UNITED STATES COMMISSION OF FISH AND FISHERIES.

PART XII.

REPORT

OF

THE COMMISSIONER

FOR

1884.

A.—INQUIRY INTO THE DECREASE OF FOOD-FISHES.
B.—THE PROPAGATION OF FOOD-FISHES IN THE WATERS OF THE UNITED STATES.

WASHINGTON:
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1886.

Resolved by the Senate (the House of Representatives concurring), That the report of the Commissioner of Fish and Fisheries for the year 1884 be printed, and that there be printed 11,000 extra copies, of which 3,000 shall be for the use of the Senate, 6,000 for the use of the House of Representatives, 1,500 for the use of the Commissioner of Fish and Fisheries, and 500 for sale by the Public Printer, under such regulations as the Joint Committee on Printing may prescribe, at a price equal to the additional cost of publication and 10 per cent thereto thereon added, the illustrations to be obtained by the Public Printer, under the direction of the Joint Committee on Public Printing.

Agreed to by the Senate June 27, 1884.

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REPORT OF THE COMMISSIONER.

A.—GENERAL CONSIDERATIONS.

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It is proposed to give in the present report (the twelfth of the series) an account of the plans and results of the work of the U. S. Fish Commission during the calendar year 1884. This, with the preceding reports, covers thirteen years of activity—from the year 1871 to 1884, inclusive.

It is to be borne in mind that the work of the Commission at its commencement, in 1871, was limited to investigations into the causes of, and remedies for, the decrease of the food-fishes on the sea-coast and in the lakes of the United States, and that in 1872 the work of propagation of food-fishes was added to the functions of the Commissioner. Giving the fullest interpretation to these requirements, the work of the Commission is now divided into the two divisions of inquiry and of propagation, certain additional subjects of attention connected with the history and condition of the inhabitants of the waters that do not come specifically under either of these heads forming a third section.

Under the head of inquiry are prosecuted researches, not only into the habits and characteristics of the fishes themselves, but into their general relationships to each other and to man; the statistics and methods of their capture; the influences exerted upon their movements by physical and other causes; and, in short, whatever information is necessary for a satisfactory and proper treatment of the general subject. It was in connection with this matter that co-operation was extended to the work of the United States Census of 1880, by which the Fish Commission took charge of the collecting of all the statistics of the fisheries considered desirable by the Superintendent of the Census, and carried the work to a satisfactory termination, resulting in the production of a series of valuable reports which are now being printed under the auspices of the Census Bureau or by the Fish Commission, under authority of Congress.

The phrase "propagation of food-fishes" covers all the methods by which new varieties of fishes, mollusks, &c., are introduced into given waters or increased in their native localities; this being done either by transfer and colonization or by artificial propagation.

As stated in previous reports, the Fish Commission has been enabled to do a great deal incidentally in the way of promoting science and education; especially by the discovery of many rare forms of life in the waters, and by the accurate labeling and extensive distribution of duplicates of these objects to colleges and academies throughout the country; the reserve specimens, of course, going, under the law, to the National Museum.

In addition to the usual routine operations of the Commission during the year, in the way of general administration, of inquiry, and of propagation, the following specially noteworthy points may be indicated as having engaged its attention. These will be referred to more fully hereafter:

1. The vigorous prosecution of work on the Wood's Holl pier and breakwater, the completion of the quarters and water-tower buildings, and the commencement of the hatching house.

2. The construction of oyster ponds at Wood's Holl and at Saint Jerome station, and the investigation of the oyster-beds of Chesapeake Bay.

3. The trip of the Albatross to the Caribbean Sea for the purpose of prosecuting hydrographic and fisheries work.

4. The investigation of the Florida shad fisheries by the steamer Fish Hawk.

5. The examination of the oyster-beds of Long Island Sound by the steamer Lookout, under the direction of Mr. E. G. Blackford.

6. The investigation of the fish epidemic in Lake Mendota and other lakes of Wisconsin.

7. The collection of specimens of Cetaceans, through the co-operation of the Life-Saving Service.

8. The construction of a third car for transporting and hatching fish and eggs.

9. The introduction of the cod gill-net upon the Pacific coast.

10. The occupation of Fort Washington, on the Potomac River, for shad hatching, by permission of the Secretary of War.

11. The occupation of a station at Weldon, N. C., for propagating striped bass or rockfish.

12. The efforts to hatch the codfish at the Wood's Holl station.

13. The planting of lobsters in Chesapeake Bay.

14. The importation of blue carp from Germany, and of the European trout (*Salmo fario*) from Germany and England.

15. The appointment by the Senate of a standing committee on fish and fisheries, to consist of seven Senators.

16. The appropriation by Congress of $75,000 for the purpose of making exhibits at the New Orleans Exposition.

17. The passage of bills in Congress, to prohibit the use of nets in capturing fish in the District of Columbia, and to prevent the discharge of refuse from the gas-works into the Potomac River near Washington.

A more detailed statement of the ends which the Commission is at present endeavoring to accomplish will be found in the Commissioner's report for 1883 at page xx.

The amount of work connected with the administration of the business of the Commission for the year has been fully equal to that of 1883. The number of sets of vouchers prepared in duplicate, audited, and properly settled footed up to 2,769; the number of letters written during the twelve months ending June 30, 1884, amounted to 8,836; of letters received, 13,744. Of applications for fish 10,300 were received, or an aggregate of 35,649 documents require entry, analysis, and indexing.

No casualties have occurred during the year in the immediate *personnel* of the Commission, and no serious interruption of work in consequence of the death of any of its members. I may, however, mention the death of Mr. Reuben Wood, of Syracuse, N. Y., on February 16, 1884; a gentleman well known in New York as an angler, and who represented angling interests in the display of the U. S. Fish Commission at the London Fisheries Exhibition of 1883.

2.—PRINCIPAL STATIONS OF THE COMMISSION.

A.—INVESTIGATION AND RESEARCH.

1. *Gloucester, Mass.*—In the summer of 1877 Gloucester was made a station for the fisheries investigations, and an office established, through which it became possible to secure a great amount of help from the fishermen in the way of contributions of information and of specimens brought in from the Banks. The office was placed in charge of Capt. S. J. Martin. A reorganization of this office was made in February, 1885, by putting Mr. W. A. Wilcox, formerly secretary of the Boston Fish Bureau, in charge; and to him, with Captain Martin as assistant, has been given authority to collect the statistics referred to, which he has accomplished in a more thorough and exhaustive manner than has heretofore been done. The information thus obtained has been of the utmost importance and of a character greatly needed for determining the value to us of the fishery operations, and especially of the participation in the British inshore fisheries. The expiration of the treaty of Washington on June 30, 1885, makes this information of very great usefulness.

2. *Wood's Holl, Mass.*—This station, which is in charge of Capt. H. C. Chester, is increasing rapidly in prominence in the operations of the Commission in connection with the approaching completion of the buildings authorized by Congress for the prosecution of special researches, and the practical propagation, in an artificial way, of cod, mackerel, lobsters, and other sea fish. A fuller account of the plant and operations at Wood's Holl, will be given hereafter.

3. *Saint Jerome, Md.*—This station, which is in charge of W. de C. Ravenel, is maintained especially for practical tests in oyster culture.

B.—PROPAGATION OF SALMONIDÆ.

4. *Grand Lake Stream, Me.*—The propagation of the landlocked or Schoodic salmon is carried on here under the direction of Mr. Charles G. Atkins.

5. *Bucksport, Me.*—The work of this station, also in charge of Mr. Atkins, is primarily connected with the multiplication of Penobscot salmon.

6. *Northville, Mich.*—At this establishment is carried on the propagation of whitefish, the eggs of which are collected by Mr. F. W. Clark and his assistants, and either forwarded to distant points or entirely hatched out and the minnows transmitted to suitable localities. The station is also used for breeding the Eastern brook trout and the California trout.

7. *Alpena, Mich.*—This is an auxiliary station for the whitefish service, and is also under the direction of Mr. Clark.

8. *Baird, Shasta County, Cal.*—This station, on the McCloud River, is devoted exclusively to the cultivation of the California salmon, for which it is eminently adapted. The work was suspended during the present year.

9. *Trout ponds near Baird, Shasta County, Cal.*—This station, situated about 5 miles from the salmon station, is devoted to keeping up a large stock of California trout to supply eggs for eastern waters.

10. *Wytheville, Va.*—This station is rented from the Virginia fish commission in order to obviate the expense otherwise attendant upon the transporting of the young Salmonidæ, such as California trout, brook trout, landlocked salmon, &c., from Northville, Mich., and other stations, to distant points, especially the southern Alleghanies.

11. *Cold Spring Harbor, N. Y.*—For the purpose of hatching eggs of the salmon and of the whitefish for introduction into the rivers and lakes of Northern Pennsylvania, New York, and other adjacent States, arrangements were made through Mr. E. G. Blackford, one of the fish commissioners of New York, to occupy, in part, the station of the New York fish commission at Cold Spring Harbor, Long Island. This place is in convenient proximity to New York, and consequently enjoys excellent facilities for transportation and distribution. It is in charge of Mr. Fred Mather, who carries on, simultaneously, work for the State of New York and for the United States.

C.—PROPAGATION OF SHAD.

12. *Battery Station, Havre de Grace, Md.*—The work connected with the propagation of shad in their breeding grounds in the Susquehanna River, previously carried on by barges anchored in Spesutie Narrows, has been transferred to an island known as Battery Island, which is a

few miles below the railroad bridge at Havre de Grace. The facilities already established at this station were extended during the year, with the expectation of their yielding large results.

13. *Central Station, Washington, D. C.*—This station, established in the old Armory building, now constitutes an important point for hatching shad, herring, salmon, whitefish, and several other species, and for their distribution by cars to distant parts of the country.

14. *Fort Washington, Md.*—This point was occupied in 1883 for the first time, by permission of the War Department, and placed in charge of Lieut. W. C. Babcock, U. S. N. Its occupation was continued by Lieutenant Babcock during the season of 1884, and large quantities of shad eggs were collected and sent to Central Station for hatching.

D.—PROPAGATION OF CARP.

15. *Monument Reservation, Washington, D. C.*—This is the principal station for the production of carp. The varieties cultivated are the leather and mirror carp. Goldfish (*Cyprinus auratus*), golden ides, and tench are also raised in considerable numbers.

16. *Arsenal Grounds, Washington, D. C.*—Cultivation at this station is confined to the scale carp.

Fuller details in regard to the work and results of all these stations will be found under the head of the specific work for which they are maintained.

3.—NEW HATCHING STATIONS DESIRED.

Efforts are constantly being made to induce the Commission to increase the number of propagating stations in order to hasten the accomplishment of the results desired; but it has been necessary to proceed very carefully with such measures, and only in proportion to the increase of appropriations made by Congress. There is no doubt that a number of new stations might be established to advantage, and it is hoped that the means will be allowed at no distant time for doing so; but nothing has been done during the year in this connection, although the facilities of operations at several of the old stations have been greatly enlarged.

The suggestion has been made, through Mr. Livingston Stone, by the inspector of fisheries of British Columbia, that a joint hatchery should be started by the two Governments, for the purpose of increasing the supply of the Columbia River catch, and of introducing the Columbia River salmon into the Fraser River. Nothing, however, has been done in this connection. A hatchery within the United States on the Columbia River itself has also been proposed and zealously urged, as also a station in Colorado or elsewhere in the Rocky Mountain region to develop the possibility of cultivating the Rocky Mountain trout (*Salmo purpuratus*):

There is a great demand also for additional stations for the propagation of shad, which, like those just mentioned, will receive due consideration whenever practicable. In the foot-notes will be found some letters of interest which bear upon this general subject.

4.—VESSELS OF THE UNITED STATES FISH COMMISSION.

A.—THE STEAMER ALBATROSS.

The steamer Albatross, under the direction of Lieut.-Commander Z. L. Tanner, U. S. Navy, continues to work very satisfactorily in connection with the objects of the Commission.

Her services as a fishing vessel not being required during the winter, a request from the Navy Department that she be employed in hydrographic work in the Caribbean Sea was considered and approved, with the agreement that all the expenses of the voyage were to be met by the Department and the vessel returned to the Commission at the Washington navy-yard exactly in the same condition as when she left; and with the understanding also that a reasonable amount of time should be devoted to the prosecution of deep-sea research. The steamer proceeded accordingly from Washington to the Norfolk navy-yard, sailing thence direct for Saint Thomas on the 10th of January, 1884, arriving there on the 17th; starting again on January 24, a series of soundings was commenced, to extend from Santa Cruz to Porto Rico, as also to the Aves

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VICTORIA, B. C., *January* 19, 1884.

DEAR SIR: Your kind favors of December 17 concerning lobsters, &c., and also one of January 9 in regard to salmon hatching trays, are to hand, for which please accept my thanks for your valuable information. I shall be most happy to write Mr. Redcliff on the subject.

The inspector of fisheries spoke to me to-day about the matter of establishing a joint hatchery on the headwaters of the Columbia River, in order to increase the supply of the Columbia River catch and introduce the Columbia River salmon into the Fraser River. I should think the matter could easily be arranged, as the Shuswap Lake and the north branch of the Columbia River are only 25 miles distant *via* Eagle Pass. This will be a short distance to carry fry when once the railroad is completed.

The Governments would have to arrange this matter, and I think it would be an advantage on both sides to have it done.

Yours very respectfully,

THOMAS MOWAT.

LIVINGSTON STONE, Esq.

SENATE CHAMBER, *Washington, D. C., February* 5, 1884.

SIR: I beg leave to ask your favorable consideration of a suggestion that you send a vessel to Florida during the present month and establish, at such place as shall be best suited, a station for hatching shad, in some of the waters of Florida. This is the spawning season, and

Islands, which were reached on the 27th. Boca Grande was visited on the 30th.

On February 3 the steamer proceeded to the Gulf of Paria, and thence to Curaçao. In this vicinity soundings were taken at the express request of the governor. The vessel next proceeded to Santiago de Cuba, which was reached on February 26, and Kingston, Jamaica, on March 2. Here some necessary repairs were made, and an additional supply of sounding weights taken on board. Leaving Kingston on March 11, Savanilla was reached on the 16th, and Aspinwall on the 26th, where on landing was made, on account of the prevalence of yellow fever.

The vessel then started homeward by way of Old Providence Island, where some interesting observations and collections were made. She arrived at Key West on April 15, and was delayed until the 27th for repairs. She then proceeded to Washington by the way of Havana, and arrived at the Washington navy-yard on May 16th. Extensive repairs to boilers were found necessary, and in accordance with the arrangement with the Navy Department the steamer was put in thorough order at its expense.

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the opinion generally prevails that the fish hatched in the southern waters are better adapted to that part of the United States.

This is a subject of general interest to the people of the Southern States, and I respectfully suggest that the interest of this industry will be greatly promoted if such a station can be established immediately.

Respectfully,

WILKINSON CALL.

Hon. SPENCER F. BAIRD.

Public resolution No. 35.

JOINT RESOLUTION authorizing the Secretary of War to lease certain lands to the board of fish commissioners of the State of Michigan.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War is directed and hereby duly authorized to lease to the State board of fish commissioners of the State of Michigan the parcel or strip of land lying north of and adjoining the Saint Mary's Falls Ship-Canal, and between said canal and the rapids of the Saint Mary's River, in the county of Chippewa and State of Michigan, including such portion of the lands reserved for the use of the canal as are not now needed for canal purposes, upon condition that the premises so leased are to be used solely by said commissioners for the culture and propagation of food-fishes and the residence of the employees of the commission, and that the use of said premises by them shall in no way interfere with the use of the same lands for canal purposes whenever required by the United States Government. The Secretary of War is requested to cause the removal of all persons now occupying any part of the said premises on or before July first, anno Domini eighteen hundred and eighty-four. The lease to said commissioners shall be rent free, and the buildings to be erected by said commissioners shall be first approved by the engineer officer in charge of the canal.

Approved June 26, 1884.

On July 13 she went to sea to investigate the migrations of the menhaden and mackerel from the capes of the Chesapeake to the Gulf of Maine, and reached Wood's Holl, Mass., on July 26. In August a number of dredging and exploring trips were made from Wood's Holl. During the summer the Secretary of the Navy, Hon. W. E. Chandler, made application for the use of the vessel for a few days at Newport, during a review of the vessels of the North Atlantic squadron and an inspection of the torpedo practice by the President and other public officials, which was granted. In September numerous trips were made to the fishing grounds for the purpose of studying their character, and on October 8 the vessel proceeded to New York, and thence to Washington, where she arrived on the 23d.

Congress having authorized and ordered an exhibition by the U. S. Fish Commission at the International Exposition at New Orleans, it was determined to make the Albatross one of the features of display on that occasion, and to combine with it a research into the fisheries of the Gulf of Mexico. The vessel having been properly refitted and supplied with coal left Washington on the 24th of December, 1884. The details of her winter cruise, and of her presentation at the New Orleans Exposition, will be found in the report for the year 1885.

Accompanying the appended report by Captain Tanner of the work of the Albatross for the year 1884 will be found full details as to list of officers and specialists on board and of her several exploring trips.

B.—The Steamer Fish Hawk.

With a view to ascertain whether anything could be done to increase shad in the Southern rivers by transferring the hatching operations to those rivers, this vessel was ordered early in the year to make a reconnaissance of certain streams in South Carolina and Florida. She left Washington on March 8 and proceeded to the Saint Mary's River, arriving at King's Ferry, Fla., March 10. After visiting Fernandina on the 31st, and touching at Savannah and Charleston, a landing was made at Georgetown, S. C., and the fisheries of Winyaw Bay were examined, and the vessel returned to Washington the 10th of April. Reports of the results obtained by Lieutenant Wood have already been published in the Bulletin for 1884, pages 140, 241, and 242. Lieutenant Wood expressed the opinion that these waters afforded little encouragement for artificial propagation. From April 24 to April 28 the Fish Hawk was engaged in a cruise of investigation in the lower part of Chesapeake Bay to ascertain the character of the fisheries for shad, herring, &c. An account of this trip will be found in the Fish Commission Bulletin for 1884, page 199.

From the 1st of May to the 27th the vessel was occupied in shad hatching on the Upper Potomac and located near Bryant's Point. From June 23 to July 7 she was engaged in transporting supplies from Washington to Saint Jerome and Battery Stations.

On the 9th of July the vessel proceeded from Washington to Wood's Holl with freight for that station, and thereafter, during the remainder of July and August, made dredging trips from Wood's Holl. Aid was also rendered to the officers and crew of the U. S. S. Tallapoosa, which sunk in Vineyard Sound August 22. On the 14th of October the Fish Hawk was loaded with freight to be returned to Washington. On the way some lobsters were obtained in New York for transfer to the mouth of the Chesapeake. Sixty-three of these were deposited off Back River light on October 19, an account of which transaction will be found in the Fish Commission Bulletin for 1885, page 31. The vessel reached Washington on October 20. During the greater part of November the Fish Hawk was engaged in investigating the oyster-beds of Chesapeake Bay, under the direction of Mr. T. B. Ferguson. On December 31, 1884, Lieutenant Wood was relieved from duty in the Fish Commission, and the command of the vessel, then at the navy-yard in Washington, was transferred to ensign L. W. Piepmeyer, U. S. Navy.

C.—The Steamer Lookout.

On the 1st of January, 1884, Mate James A. Smith, U. S. Navy, was detached from duty with the U. S. Fish Commission steamer Fish Hawk, and ordered to the command of the Lookout. Mr. Smith at once took charge of the repairs and alterations which had been commenced in the fall for the purpose of better adapting the vessel for the special work of propagation and investigation, to which she would be assigned.

The steamer left the ways on April 30, and on May 17 a short trial trip was made down the river as far as Fort Washington. During the latter part of May and throughout the month of June the steamer was run between Washington, Saint Jerome, and Battery Stations, transferring launches, seine-boats, and other freight, from station to station, as needed. On June 27 the Lookout was ordered to Saint Jerome Station for the purpose of prosecuting certain work in conjunction with the steamer Fish Hawk, which was then on the ground.

In order to complete the tests of the different forms of propellers, for which the vessel had been placed at the disposal of the Bureau of Steam Engineering, a second board of engineers was appointed by the chief of the Bureau, and on July 3 additional experiments were made, the steamer making three round trips between Giesboro' Point and Marshall Hall. These trials were supplemented on August 5 by further tests with a still different form of propeller, which had been placed on the vessel in the mean time. A very complete and interesting report of the results of the various experiments has been published by the Bureau of Steam Engineering.

From the 10th to the 30th of July the Lookout was employed in the neighborhood of Crisfield, Cherrystone, and Hampton Roads in procuring information as to the catch of Spanish mackerel, &c., and in conducting experiments as to their artificial propagation.

On the 30th, through the courtesy of the Treasury Department, the vessel was examined by the local inspector at Norfolk. After some service in the neighborhood of Saint Jerome Station, the Lookout was ordered to the Delaware Bay for the purpose of continuing the Spanish mackerel investigations, but having broken her propeller off Chincoteague, was compelled to return to Norfolk, in which vicinity she was detained until the latter part of August, unfortunately too late for the mackerel spawning season in the Delaware. The vessel was thence transferred to the Wood's Holl Station.

Shortly after her arrival, on application of Mr. E. G. Blackford, one of the fish commissioners of New York, she was detailed for service with that commission to enable it to make some investigations as to the condition of the oyster-beds in Long Island Sound. From there she was transferred to the Great South Bay, where an investigation of the marine fauna was being conducted under the supervision of Dr. Tarleton H. Bean. On the completion of these assignments by October 8, the Lookout returned to Wood's Holl and was used to transfer the launch and small boat from that station to Battery Station, at Havre de Grace.

During the month of November she was used in the transfer of equipment between Battery and Saint Jerome Stations and in the investigations of the oyster-beds of Tangier Sound and the Chesapeake Bay in the neighborhood of Point Lookout.

On the Lookout's return from Washington to Baltimore she rescued the disabled schooner American Coaster off Annapolis and towed her to Baltimore.

During the month of November the vessel was used in towing lumber, coal, &c., from Havre de Grace to Battery Station, until work was discontinued on account of the closing of navigation in the upper bay by ice. On the 23d of December the Lookout was transferred from Battery Station to Baltimore, and there fitted out for a trip to the Southern Atlantic and Gulf coasts.

D.—Assignments of Naval Officers.

The list of changes in the assignment of naval officers connected with the service of the Fish Commission, either on vessels or on shore, has been as follows:

On February 6 Passed Assistant Engineer W. L. Bailie was detached from the Fish Hawk and ordered to shore duty at Wood's Holl, Mass.; and on the 8th of February Passed Assistant Engineer I. S. K. Reeves was ordered to the Fish Hawk.

On March 6 Ensign L. W. Piepmeyer was detailed from the Tallapoosa and sent to the Fish Hawk as first officer.

On June 18 Surgeon C. G. Herndon was relieved from duty with the Albatross and Surgeon J. M. Flint ordered in his stead.

On July 24 Lieut. William C. Babcock, who had been on the staff of the Commission for some time, was detached and ordered to the Lackawanna at Panama.

Lieut. Francis Winslow, who had also been on special duty with the Commission, was detached on August 17.

On December 31 Lieut. W. M. Wood, commanding the Fish Hawk, was detached, and Ensign Piepmeyer placed temporarily in command.

E.—Other Vessels.

For some time past the importance of having a vessel constructed specially for transporting living fish, such as cod, halibut, &c., from the fishing grounds to the Wood's Holl or other shore station, where the eggs could be obtained and properly fertilized, has been manifest, and Capt. J. W. Collins, of the Fish Commission, was requested to prepare plans for this purpose. He has devoted several years to this investigation, and during his visits as an officer of the Commission to the fisheries exhibitions at Berlin in 1880 and at London in 1883, paid special attention to the problem, studying the features of construction of the fishing vessels, particularly of England and Holland, and furnishing some important ideas which have been embodied in the plans and specifications prepared under his direction. An appropriation of $14,000, the estimated cost of the vessel, has been asked for from Congress, and it is to be hoped will be granted. As soon as the money is available bids will be invited and contracts entered into for the completion of the vessel at the earliest possible time. The details of this vessel will probably be given in the report for the year 1885.

The supply of small boats for the service of the Commission has been kept up at the different stations as occasion required. Among these is a catboat for communication between Havre de Grace and Battery Station.

5.—CARS.

The two cars arranged for and built within the last few years for the transportation of eggs and young fish, were reinforced during 1884 by another of admirable construction, in which the lessons of the first two were applied. An appropriation of $8,500 was made by Congress, and with this the car was built and equipped. The uses to which it has been placed will be fully detailed in a subsequent part of this report.

6.—COURTESIES EXTENDED TO THE UNITED STATES FISH COMMISSION.

A.—By the Government.

Treasury Department.—*Secretary's Office.*—Assistant Secretary H. F. French, on March 10, issued instructions to custom-house officers

at Boston and New York to admit fish and eggs free of duty from foreign countries, and to afford every facility for the prompt and careful transfer of these fish to the shore.

Light-House Board.—The Light-House Board, on March 19, granted to the Commission the use of a room in the light-keeper's house at Battery Station; on April 28 it authorized the further use of the storage building at Wood's Holl, previously occupied by the Commission, and on June 2 granted permission to take specimens of sea-lions from the Farallon Islands. The Board has also continued to assist in taking ocean temperature observations at about thirty-six of the light-houses and light-ships most favorably located.

Coast Survey.—The frequent calls upon the Coast Survey for tide-tables, maps, and charts required for the use of the different vessels of the Fish Commission have always been promptly complied with.

Life-Saving Service.—The arrangement made by the Superintendent of the Life-Saving Service for the telegraphic announcement to the Smithsonian Institution of the stranding of marine animals, has continued to be productive of important results, and the specimens obtained have proved to be most valuable.

WAR DEPARTMENT.—The Hon. Secretary of War, Robert T. Lincoln, granted authority to occupy the fishing-shore at Fort Washington, for the purpose of shad hatching, with the permission to use one of the buildings at the fort as headquarters for the men.

Signal Office.—General Hazen kindly furnished weather indications by telegram to Wood's Holl during the summer season. He also replaced several broken thermometers for the use of light-house keepers in taking temperature observations.

NAVY DEPARTMENT.—The officers and crews of all the vessels of the Fish Commission have been furnished by the Navy Department during the year, and all the facilities of the navy-yards, particularly that at Washington, have been extended to the Commission. The Boston navy-yard also lent to the Wood's Holl Station many needed tools.

Bureau of Construction and Repair.—The chief of the Bureau authorized the use of an unfinished launch, which was completed and used by the Commission in shad work on the Potomac River.

Bureau of Steam Engineering.—On March 13 Commodore Charles H. Loring granted the loan of a steam-launch boiler and engine for the use of the uncompleted launch referred to above.

Bureau of Equipment and Recruiting.—Coal was furnished the Fish Commission vessels by navy-yards upon requisition, as in the preceding year.

INTERIOR DEPARTMENT.—*Patent Office.*—The Commissioner of Patents has supplied the Fish Commission with the Official Gazette and other information with reference to patents relating to fish and fishing apparatus.

POST-OFFICE DEPARTMENT.—In December a daily mail was substituted for a semi-weekly mail to Baird, Cal., from Redding, by order of George M. Sweeny, Acting Second Assistant Postmaster-General.

SENATE AND HOUSE OF REPRESENTATIVES.—*Folding-Rooms.*—The superintendents of the Senate and House folding-rooms kindly consented to envelop the Fish Commission reports for 1881 as heretofore.

HEALTH OFFICE.—Statistics of the Washington fish-market have been furnished in monthly tables, which, after being compiled in the Fish Commission Office, were published in the Bulletin for 1885.

B.—BY THE RAILROADS OF THE UNITED STATES.

Since the introduction of transportation-cars the distribution of fish and eggs in the baggage-cars of the ordinary passenger trains has been largely given up, being now employed only for localities within a few miles of Washington or some other fish distributing center.

Many of the railroads in the United States have agreed to carry these cars on passenger trains for a small sum, generally not to exceed 20 cents per mile for the car and five messengers. A list of the principal roads charging 20 cents per mile or less will be found in the supplement.

While the greater part of this service was furnished at the rate of 20 cents per mile, not less than 8,176 miles of transportation were furnished entirely free of cost. This, at the rate mentioned, would amount to $1,635.20.

C.—BY STEAMSHIP COMPANIES.

The foreign steamship companies have continued their usual liberal treatment of the Commission by the free transportation of fish and eggs, no charge having been made by them for the many sendings to Europe or for those received in return.

The shipments made through these agencies are shown under the following headings:

D.—COURTESIES FROM FOREIGN COUNTRIES.

Germany.—Another attempt to send blue carp from Germany was successfully made by Herr Max von dem Borne. On March 5th the steamship Werra left Bremen with 100 blue leather carp, of which number 45 arrived in New York on March 17. Mr. R. Hessel, superintendent of the carp ponds at Washington, met them in New York and immediately transported them to Washington. The fish, although weak on their arrival, were in a few days in good condition.

On February 15th 60,000 eggs of the German trout (*Salmo fario*) from Herr von Behr, were received and repacked by Fred Mather. Sixteen thousand were of the large variety, and 44,000 were of the small kind. Some of each were sent to Caledonia, N. Y., and to the Cold Spring Harbor, Northville, and Wytheville Stations.

December 10, 1884, Mr. Paul Matte, of Gross Lichterfelde, Prussia, sent to the Fish Commission, per steamer Werra, 5 specimens of macropods, or paradise fish, all of which died shortly after their arrival.

Great Britain.—On December 20, Sir James G. Maitland, Stirling, Scotland, sent 100,000 Loch Leven trout eggs by steamship Furnessia. They arrived in New York, January 2, in good condition. The National Fish Culture Association of Great Britain offered to assist the Fish Commission in obtaining turbot and sole.

There arrived at New York, by the White Star Line, on February 25, 10,000 German trout (*Salmo fario*), a present from R. B. Marston, editor of the Fishing Gazette, to the American Fish-Cultural Association. The eggs were taken charge of by Mr. Mather and forwarded to the Cold Spring Harbor hatchery.

7.—COURTESIES TO FOREIGN COUNTRIES.

During the present year the requests for fish and fish eggs from foreign countries have been granted where the proposed shipments were not impracticable or where the requests were not received too late in the season to send the kinds of fish and eggs desired. When such was the case a promise to send the following season was made. The countries receiving courtesies from the Commission are Belgium, France, Germany, Great Britain, Mexico, Netherlands, and New Zealand. Black bass, blue carp, catfish, golden ides, and leather and mirror carp, and the ova of brook trout, lake trout, landlocked salmon, rainbow trout, and whitefish have been furnished.

The condition of the fish and eggs on their arrival at the various points of destination can be seen by reference to the paragraphs devoted to the respective countries below.

Australia.—Under date of January 25 the Australian Fish Acclimatization Society at Ballarat, Australia, made a request for lake trout ova. The request, however, could not be granted, it being made too late in the season, but an offer was made to send a lot in the following December should they be desired then.

Belgium.—On November 15, 1884, ten cans, containing 100 catfish, were shipped by steamer Rhineland to Alfred Lefebvre, Ghent, Belgium. Under date of November 28, Mr. E. Williquet reported the safe arrival of 95 of the fish.

France.—Three thousand eggs of the rainbow trout were forwarded by steamer Normandie to the Société d'Acclimatation, Paris, France. Mr. C. Raveret-Wattel, secretary of the society, under date of May 18, reported that they arrived in "splendid condition."

Germany.—A shipment of 1,000,000 whitefish eggs, 25,000 brook trout eggs, and 25,000 lake trout eggs, all in good condition, was made on January 12, to Herr von Behr, president of the Deutsche Fischerei-Verein, Berlin, in the care of F. Busse, Geestemünde, by the North

German Lloyd steamer Neckar. A letter from Herr von Behr stated that the eggs arrived "in the most perfect state."

On March 20th, 12,000 eggs of the rainbow trout were received from the Northville Station, at Cold Spring Harbor, New York, where they were to be repacked for shipment to Germany. On unpacking the eggs it was found that they were too far advanced for shipment, many having already hatched on the way and died. These were exchanged for another lot, which, though not quite so far advanced, were rather old for shipment abroad. They were transported by a steamer of the North German Lloyd Line which sailed on March 29. These eggs did not arrive in good order, but Herr von Behr, who first wrote that he did not think a single egg would give a healthy fry, afterwards reported that they had done better than was first anticipated.

At the request of Max von dem Borne, of Berneuchen, 100 big-mouthed black bass (*Micropterus salmoides*) were shipped on March 26, by Bremen steamer, to the care of the Havre Aquarium at Havre, France. The bass, however, died *en route.*

Great Britain.—A shipment of 5,000 Schoodic salmon eggs was made to Sir James Gibson Maitland, Howietoun Fishery, Stirling, Scotland, by steamer Baltic, of the White Star Line, on the 8th of March. Under date of March 21, they were reported as having arrived on the 19th in "first-class condition," there being "only about twelve white eggs, ten of which were unimpregnated."

On the 14th of February a request for rainbow trout eggs was made by Hon. Edward Birkbeck, M. P., on behalf of the National Fish Culture Association, South Kensington, London, England. Accordingly, 3,000 eggs were forwarded on April 18, by steamer Assyrian Monarch, of the Monarch Line. The shipment did not meet with that success which usually attends shipments of eggs to Great Britain. Under date of May 15, Hon. Edward Birkbeck, M. P., vice-chairman of the association, announced that on the arrival of the steamer the eggs were found frozen through and killed. Fish eggs are usually placed in the provision room of the steamer, but on this occasion they were stored in the beef room, where the temperature was said to be from 35° to 40° F. If the eggs were frozen on their arrival in London, the temperature must have lowered considerably.

Mr. W. T. Silk was dispatched to America early in October, and commissioned to procure specimens of black bass, carp, and other species. On presenting his credentials, he was furnished by the Commission with 100 leather carp, 100 mirror carp, 20 blue carp, and 10 golden ides. Under date of Burghley, Stamford, England, November 25, Mr. Silk transmitted the thanks of the Marquis of Exeter, president of the National Fish Culture Association, for the fish presented by this Government.

In response to a request from Dr. Michael Beverley of Norwich, England, who was in attendance upon the Montreal meeting of the

British Association for the Advancement of Science, in September, 10 blue carp, 10 leather carp, and 10 golden ides were sent to his address in New York to be taken by him to England. On Dr. Beverley's arrival in England he reported that during the voyage the ides died, owing to decomposition of the water, in which plants had been placed for the purpose of purifying and aerating it. The water in which the carp were placed was changed and the plants removed, thereby insuring the safe arrival of the fish in England. These were planted in his pond on the 4th of October.

Mexico.—Reports of the Commission were furnished the Mexican Government in response to a request from the secretary of the board of public works, transmitted through the Mexican minister at Washington. Pamphlets on carp culture were also forwarded and a willingness expressed to supply the Mexican Government with fish as soon as the necessary preparations were made for their reception.

Netherlands.—In response to a request from Dr. C. Kerbert, manager of the aquarium of the Zoological Society of Amsterdam, for black bass, a lot of 18 was sent on June 3, 1884, by steamer Scheidam. A special apparatus to be used in the transportation of the bass was constructed, but owing to its large size, the captain of the steamer refused to take it on board. He, however, promised to provide all necessary room on the ship; and in large tanks and casks, which were provided, it was thought that the bass would reach Amsterdam alive. Under date of June 24 the bass were reported as dead on the arrival of the steamer.

New Zealand.—Mr. Frank N. Clark, of Michigan, accompanied the 1,000,000 whitefish ova for the Nelson Acclimatization Society as far as Omaha, Nebr., thus precluding delay of arrival at San Francisco. Mr. Robert W. J. Creighton, of San Francisco, announced the arrival of the ova in fine condition, and stated that they were safely packed in the ice-house of the steamer, which sailed at midnight on January 21. The ova were reported by Mr. Alfred Greenfield, secretary of the Nelson Acclimatization Society, as having arrived on the 11th of February. Ova from four of the nineteen trays were placed in the hatching boxes of the society. The following morning a large number were hatched. A large proportion of the eggs, however, were in bad condition, owing to delay at Auckland. The remaining fifteen trays were sent to an inland lake 54 miles distant, where two-thirds of the ova hatched. The young fish were reported as growing and as in a thriving condition.

8.—RESHIPMENT TO AND INSTALLATION IN THE NATIONAL MUSEUM OF THE EXHIBITS SENT FROM THE UNITED STATES TO THE INTERNATIONAL FISHERIES EXHIBITION IN LONDON, 1883.

The repacking and shipment of these exhibits to the United States were commenced immediately after the close of the exhibition in London on October 31, 1883, and the last car-load was received at the National

Museum early in the spring of 1884. The unpacking and installation of these collections, together with the new material obtained for the Museum from the collections of other countries at this exhibition, occupied a great deal of time in the early part of the year; and on the the evening of May 14 the "fisheries section" of the National Museum was formally opened to the public. The building was illuminated by electric lights, gratuitously furnished for the occasion by the Brush-Swan Electric Light Company. During the evening an informal reception was held by the U. S. Fish Commissioner. The number of visitors on that occasion was two thousand and thirty-three. The Report of the National Museum for 1884 will contain a fuller account of the character of the collections.

Reception of medals.—Early in the year the medals, which had been awarded by the juries to American exhibitors, were received. These numbered one hundred and twenty-seven, and were distributed by the U. S. Fish Commission. Of this number fifty were gold, forty-seven silver, and thirty bronze.

Reception of diplomas.—These, one hundred and forty-two in number, were received late in the summer, and distributed in the same manner.

Special prizes.—Seven special prizes, amounting in value to £65 sterling, were awarded to United States exhibitors, and forwarded to them.

The special report required by Congress, treating of the exhibition in London and of the status of the fishery industries in Europe, is being prepared by Mr. G. Brown Goode, late commissioner to the exhibition, and will be ready for transmission to the Secretary of State during the coming year. There has, however, been already published a series of special catalogues, constituting a report upon the exhibit of the fisheries and fish-culture of the United States, made at the London Fisheries Exhibition. These catalogues, twelve in number, form Bulletin 27 of the U. S. National Museum. The first seven were printed separately in 1883. No. 8 appeared as a separate issue in 1884, and the last four appeared for the first time in the complete volume, which has been issued during the year. The following is a list of these catalogues:

A.—Preliminary catalogue and synopsis of the collections exhibited by the U. S. Fish Commission and by special exhibitors, with a concordance to the official classification of the exhibition.

B.—Collection of economic crustaceans, worms, echinoderms, and sponges. By Richard Rathbun, curator of the department of marine invertebrates in the U. S. National Museum.

C.—Catalogue of the aquatic and fish-eating birds exhibited by the U. S. National Museum. By Robert Ridgway, curator, department of birds, U. S. National Museum.

D.—Catalogue of the economic mollusca and the apparatus and appliances used in their capture and preparation for market, exhibited by the U. S. National Museum. By Lieut. Francis Winslow, U. S. Navy.

E.—The whale fishery and its appliances. By James Temple. Brown, assistant in the department of art and industry, U. S. National Museum.

F.—Catalogue of the collections of fishes exhibited by the U. S. National Museum. By Tarleton H. Bean, curator of the department of fishes in the U. S. National Museum.

G.—Descriptive catalogue of the collection illustrating the scientific investigation of the sea and fresh waters. By Richard Rathbun, curator of the department of marine invertebrates in the U. S. National Museum.

H.—Catalogue of the aquatic mammals exhibited by the U. S. National Museum. By Frederick W. True, curator of the department of mammals, U. S. National Museum.

I.—Catalogue of the collection illustrating the fishing vessels and boats, and their equipment; the economic condition of fishermen; anglers' outfits, &c. By Capt. J. W. Collins, assistant, U. S. Fish Commission.

J.—Catalogue of the apparatus for the capture of fish, exhibited by the U. S. National Museum. By R. Edward Earll, curator of the fisheries collections, U. S. National Museum.

K.—Catalogue of fishery products and of the apparatus used in their preparation. By A. Howard Clark, assistant in the department of art and industry, U. S. National Museum.

L.—Catalogue of the fish-cultural exhibit of the U. S. Fish Commission. By R. Edward Earll, curator of the fisheries collections, U. S. National Museum, and assistant, U. S. Fish Commission.

The great superiority of the exhibit made by the U. S. Fish Commission at this exhibition, and the profound impression which the explanations of its methods and purposes of fish-culture produced upon European fish-culturists, induced the Scottish fishery board to send to the United States Prof. J. Cossar Ewart, one of its members, for the purpose of becoming practically acquainted with the systems in use in this country.

Professor Ewart succeeded Sir Wyville Thompson, the scientific head of the Challenger expedition, as professor of zoology in the University of Edinburgh, and is himself highly distinguished as an investigator. Every facility was afforded Professor Ewart in the examination of the various stations of the U. S. Fish Commission, and the following letter was written by him just before leaving New York to return to Edinburgh. He expects to revisit the United States next year in time to study the operations in the hatching of shad and fresh-water herring.

Under date of New York, November 5, 1884, he says:

"I have just returned from visiting all the stations you suggested, with the exception of Northville. I feel very grateful for the facilities given me to study the work of the Fish Commission. From what I have seen I am convinced that Scotland in doing her little has done best to follow in your footsteps, and that although your Commission has accomplished much already, it is in reality only beginning its work, a work which will be of immense national importance. There is no doubt that fish-culture has a splendid future if carried on, as it has been by your Commission, in a truly scientific spirit. When I saw Wood's Holl, with its great facilities, I felt that I might confidently return to Scotland and advise the board of fisheries to devote all the means at its disposal to improving by artificial means the sea fisheries. I am extremely grateful for your kindness, and for the courtesy extended to me by all the officers of the Commission and others it has been my privilege to meet."

9.—PARTICIPATION IN STATE AND INTERNATIONAL EXHIBITIONS IN 1884.

The Smithsonian Institution and the U. S. Fish Commission are called upon with increasing frequency to take part in great State and International Exhibitions, and it is quite evident that if this is kept up for any length of time a special and continuous service must be organized in connection with the National Museum for discharging the duties connected with these displays. The withdrawal of the services of the curators and assistants from their regular work in the Museum, for the preparation and display of collections outside of Washington, has greatly interfered with the work of the Museum, and has brought about a well-founded complaint of incompleteness and unsatisfactory presentation. The mandate of Congress, in ordering such participation, is necessarily imperative, however, and leaves no option.

The principal occasions of the kind referred to were the International Exhibition at Philadelphia in 1876, the fisheries exhibition at Berlin in 1880, and at London in 1883. Preparations of displays and their exhibition at the fairs at Louisville, Cincinnati, and the International Cotton Exhibition at New Orleans were also ordered; and it may reasonably be assumed that during the year practically one-half of the time of the Museum assistants has been required in connection with these subjects, rather than with the regular work of the Museum.

On all these occasions the National Museum and the Fish Commission have made satisfactory exhibitions, and were generally conceded to be among the best shown.

A fair proportion of medals and diplomas have been received in past years, and during 1884 the directors of the Cincinnati exhibition awarded a gold medal to the Smithsonian Institution and a silver medal to the Department of Mineralogy.

The exhibitions at Cincinnati and Louisville are closed, and the collections were either forwarded direct to New Orleans for exhibition there or returned to Washington. The New Orleans Exposition opened on the 16th day of December, although but little material was in its proper place. Great efforts, however, are being made by the administration and the exhibitors, and it is probable that everything will be in place and in running order in the course of the month of January.

10.—MEETING OF THE AMERICAN FISH-CULTURAL ASSOCIATION.

The thirteenth annual meeting of the American Fish-Cultural Association was held in the lecture room of the U. S. National Museum on May 13, 14, and 15, 1884. After the meeting was called to order the minutes of the last annual meeting were read, and the financial state of the treasury of the association favorably reported upon. During the progress of the meeting, thirty names of gentlemen were proposed for membership and elected. The first paper was read by Mr. Fred Mather, on "Fresh-water and Salt-water Hatching at Cold

Spring Harbor," in which an account was given of the work carried on there in 1883 by the United States and New York State Fish Commissions. This was followed by a paper entitled "Salt as an Agent for the Destruction of the Fish Fungus," by Prof. H. J. Rice, in which salt was preferred to asphalt, tar, or salicylic acid for the purpose indicated, having been used most successfully. Mr. Livingston Stone read a paper on "The Artificial Propagation of Salmon in the Columbia River Basin," in which the author urged very strongly the redoubled energies of fish-culturists in the propagation of salmon in that river. Dr. Tarleton H. Bean submitted a paper on "The Whitefishes of North America," in which it was stated that there were twelve recognizable species of this fish in North America. This was followed by "Notes on Landlocked Salmon," by Mr. Charles G. Atkins. This name included all those salmon of Eastern North America and Europe that passed their entire lives in fresh water. It was his opinion that these fish preferred deep water and a temperature of less than 70° Fahr.

Mr. E. G. Blackford read a paper entitled "Is Legislation Necessary for the Protection of the Ocean Fisheries?" Mr. Blackford was of the opinion that restrictive legislation would result in cutting off a large amount of cheap food from the people. He hoped, however, that Congress would take some action providing for the regular collection of fishery statistics. This was followed by a paper upon "The Florida Sponge Fishery," by Mr. Joseph Willcox. A valuable contribution entitled "Notes pertaining to Fish-Culture" was submitted by Mr. James Annin, jr., who, however, was unable to be present at the meeting. In his paper was recorded a very interesting experiment (made by himself with eggs from a healthy brook trout, impregnated by several fine males of the same species), the result of which was that of 350 eggs which had been placed for less than a minute in the spawning pan, only 6 were impregnated; of 350 eggs which remained for three minutes, 31 were impregnated; while of 350 eggs which were allowed to remain in the spawning pan for thirty minutes, 208 were impregnated. Mr. John Murdoch read a paper on "Fish and Fishing at Point Barrow, Alaska." Three species of whitefish, *Coregonus laurettæ*, *Coregonus kennicotti*, and *Coregonus nelsonii;* burbot, *Lota maculosa;* polar cod, *Boreogadus saida;* a species of salmon, *Oncorhynchus gorbuscha;* the Pacific red-spotted trout, *Salvelinus malma;* and the smelt, *Osmerus dentex*, were enumerated as objects of the fisheries. The fishery was for the most part carried on by women and children by means of "jigs" let down through holes made in the ice.

A paper was then read by Dr. James A. Henshall, on the "Comparative Excellence of Food-Fishes." In this paper the flavor only was considered, and not the nutritive qualities of the fish. For his purpose, he divided fish into four groups, fresh-water, anadromous, estuary, and marine, placing the following species at the head of each group, respectively, whitefish, salmon, pompano, and Spanish mackerel.

The members of the association then visited the National Carp Ponds. In the evening an address was delivered by Hon. Theodore Lyman, of Massachusetts, in the lecture room of the National Museum, Hon. Elbridge G. Lapham in the chair. The speaker reviewed the ancient fisheries of the world, and dwelt upon the development of fish-culture in the United States. Hon. S. S. Cox followed in his usual humorous vein. Votes of thanks were proposed, and the meeting adjourned until the next day.

On Wednesday morning Dr. William M. Hudson read a paper on "The Shell Fisheries of Connecticut," in which he explained the gradual progress of the oyster industry in that State, and expressed his desire for further State legislation for the protection of the oyster cultivators. Then followed a paper on "The Oyster Industry of the World," by Prof. G. Brown Goode, wherein an approximation of the oyster-catch of the world assigned 5,572,000,000 oysters to North America and 2,331,200,000 to Europe for the year 1882. Col. Marshall McDonald read a paper on "Natural Causes Influencing the Movements of Fish in Rivers." He believed that our river fisheries must be restored and maintained (1) by artificial propagation; (2) by the extension of the breeding and feeding areas to their natural limits; (3) by a sufficient supply of proper food, where, through man's agency, this has been diminished or destroyed; and (4) by rational protective legislation. The influence of the temperature of the water upon the movements of fish was also discussed.

At the afternoon session the following gentlemen were elected as officers of the association:

President, Hon. Theodore Lyman, M. C.
Vice-president, Col. Marshall McDonald.
Treasurer, Hon. E. G. Blackford.
Corresponding secretary, Mr. R. E. Earll.
Recording secretary, Mr. Fred Mather.
Members of the executive committee:
Mr. James Benkard.
Mr. George Shepard Page.
Mr. Barnet Phillips.
Prof. G. Brown Goode.
Dr. William M. Hudson.
Mr. S. G. Worth.

Prof. W. O. Atwater then read a very elaborate paper on "The Chemical Composition and Nutritive Value of our American Food-Fishes and Invertebrates." Three tables accompanied this paper: Table I showed the percentages of water and nutritive ingredients in the edible portion of fishes and invertebrates; Table II gave the percentages of refuse, water, and nutritive ingredients in specimens of food-fishes and invertebrates as found in the markets; Table III presented the constituents of certain vegetable foods and beverages. The comparative cost of

protein in fish and other animal and vegetable foods was also calculated.

Mr. John A. Ryder followed with a paper "On the Forces which determine the survival of fish embryos." He enunciated the principle that just in proportion as the individuals of a species are prolific in respect to the number of their germs, just in that proportion do the chances of survival of the individual germs seem to be diminished, and *vice versa*, and that this natural fecundity, or the want of it, is dependent upon the amount of protection received by the eggs in the course of development. On Thursday, May 15, the first paper was read by Mr. Richard Rathbun, entitled "Notes on the Decrease of Lobsters." Mr. Rathbun urged a thorough investigation of all points bearing upon the natural history of the species, upon the changes which have occurred in the fishery grounds, and upon the relations of the total catch for each section to the number of fishermen and traps, and the average size of the lobster taken. Mr. S. G. Worth then read a paper on "The Propagation of the Striped Bass." This was followed by a paper on the "Result of the Introduction of Gill-nets into the American Cod Fisheries" by Capt. J. W. Collins. It was his opinion that a very important step had been attained through the efforts of the U. S. Fish Commission in perfecting the method of cod gill-netting, which had been in use in American waters about five years. At 11 a. m. the members of the association went to the White House, and were introduced to President Arthur. At noon a meeting of the State fish commissioners convened in the office of the assistant director of the National Museum. The cultivation of oysters and shad was discussed, and the advice and assistance of the U. S. Fish Commissioner sought on various matters pertaining to the fisheries.

At 1 p. m. the members of the association proceeded to the Lower Cedar Point wharf, where they embarked on board the Fish Hawk, which had been tendered by the Commission for a trip to one of the shad stations on the Potomac. During the trip a meeting was held in the interest of oyster cultivation. The name of the association was also changed to "The American Fisheries Society," and twenty-one foreign gentlemen were elected corresponding members of the society.

11.—PUBLICATIONS IN 1884.

Reports.—The report for 1881 (Vol. IX) was nearly all in type at the beginning of the year. The composition was completed April 1, and the edition of bound volumes received for distribution in June.

The report for 1882 (Vol. X) was taken in hand early in the present year and pushed forward so vigorously that on the 24th of July it was all in type, and by the last of October the bound volumes were ready for distribution. A small pamphlet edition of the report proper was printed and distributed in conformity with previous practice.

The report for 1883 (Vol. XI) was commenced late in the year, and by December 31 about one-half of it was in type.

Bulletins.—The bulletin for 1883, the editorial work of which had been completed in that year, was put through the press and bindery in January and February. Bound volumes were received February 23 of the present year.

The bulletin for the current year (Vol. IV) was commenced early in the year, the first signatures being distributed May 3. Subsequent instalments were sent out August 21, September 19, October 24, and November 15. At the latter date the entire volume for the year was in type. On the 31st of December a stitched copy of the volume was received from the printer.

Pamphlets.—So great has been the demand for publications of the Commission that it has been impossible to give bound copies to all who desired them. This difficulty is, however, obviated to some considerable extent by the issuing of separate papers in pamphlet form. During the current year the following were issued:

65. BAIRD, SPENCER F. Report of the Commissioner for 1881. A.—Inquiry into the decrease of food-fishes. B.—The propagation of food-fishes in the waters of the United States.

    [From Report for 1881, pp. xiii-lxxi.]

66. SMILEY, CHARLES W. Special Bulletin: (1) Notes on the edible qualities of German carp and hints about cooking them; (2) The German carp and its introduction in the United States.

    [From Bulletin for 1883, pp. 305-336.]

67. RYDER, JOHN A. Rearing oysters from artificially fertilized eggs, together with notes on pond culture, &c.

    [From Bulletin for 1883, pp. 281-291.]

68. WEBSTER, H. E., and JAMES E. BENEDICT. The *Annelida chætopoda* from Provincetown and Wellfleet, Massachusetts.

    [From Report for 1881, pp. 699-747.]

69. RATHBUN, RICHARD. Descriptive catalogue of the collection illustrating the scientific investigation of the sea and fresh waters.

    [London Exhibition, part G, pp. 109.]

70. TANNER, Z. L. Report on the construction and work in 1880 of the Fish Commission steamer Fish Hawk.

    [From Report for 1881, pp. 3-53.]

71. RYDER, JOHN A. A contribution to the embryography of osseous fishes, with special reference to the development of the Cod (*Gadus morrhua*).

    [From Report for 1882, pp. 455-605.]

72. MCDONALD, MARSHALL. Report submitting plans and specifications of the fishways for the Great Falls of the Potomac River. P. 22.

73. BAIRD, G. W. Annual report on the electric lighting of the United States Fish Commission steamer Albatross, December 31, 1883.

    [From Bulletin for 1884, pp. 153-158.]

74. TRUE, FREDERICK W. Catalogue of the aquatic mammals exhibited by the United States National Museum.

    [London Exhibition, part H, pp. 22.]

75. GOODE, G. BROWN. The status of the U. S. Fish Commission in 1884. A review of what has been accomplished in fish-culture and the investigation of the American fisheries.

[From Report for 1884, pp. 1139–1184.]

76. RYDER, JOHN A. On the preservation of embryonic materials and small organisms, together with hints upon imbedding and mounting sections serially.

[From Report for 1882, pp. 607–629.]

77. BAIRD, SPENCER F. Report of the Commissioner for 1882. A.—Inquiry into the decrease of food-fishes. B.—The propagation of food-fishes in the waters of the United States.

[From Report for 1882, pp. xvii–xcii.]

78. SMITH, SIDNEY I. Report on the decapod crustacea of the Albatross dredgings off the east coast of the United States in 1883.

[From Report for 1882, pp. 345–426.]

79. TANNER, Z. L. Report on the work of the U. S. Fish Commission steamer Fish Hawk, for the year ending December 31, 1882, and on the construction of the steamer Albatross.

[From Report for 1882, pp. 3–34.]

80. MCDONALD, MARSHALL. A new system of fishway building.

[From Report for 1882, pp. 43–52]

81. COLLINS, J. W. History of the tile-fish.

[From Report for 1882, pp. 237–294*a*.]

82. COLLINS, J. W. Notes on the habits and methods of capture of various species of sea-birds that occur on the fishing banks off the eastern coast of North America, and which are used as bait for catching codfish by New England fishermen.

[From Report for 1882, pp. 311–338.]

83. VERRILL, A. E. Notice of the remarkable marine fauna occupying the outer banks off the southern coast of New England, and of some additions to the fauna of Vineyard Sound.

[From Report for 1882, pp. 641–669.]

84. VERRILL, A. E. Physical characters of the portion of the continental border beneath the Gulf Stream explored by the Fish Hawk, 1880 to 1882.

[From Report for 1882, pp. 1045–1057.]

85. SMILEY, CHARLES W. Report on the distribution of carp to July 1, 1881, from young reared in 1879 and 1880.

[From Report for 1882, pp. 943–1008.]

86. BEAN, TARLETON H. List of the fishes distributed by the U. S. Fish Commission.

[From Report for 1882, pp. 1039–1044.]

87. BEAN, TARLETON H. List of fishes collected by the U. S. Fish Commission at Wood's Holl, Mass., during the summer of 1881.

[From Report for 1882, pp. 339–344.]

88. SMILEY, CHARLES W. The influence of artificial propagation upon production illustrated by the salmon work of the Sacramento River, California.

[From Bulletin for 1884, pp. 201, 202.]

89. TRUE, FREDERICK W. Suggestions to the keepers of the United States life-saving stations, light-houses, and light-ships, and to other observers, relative to the best means of collecting and preserving specimens of whales and porpoises.

[From Report for 1883, pp. 1157–1182.]

Carp publications.—During the year several editions of "The carp and its culture in rivers and lakes," by Rudolph Hessel, and of "Carp and carp ponds" have been printed and distributed to the numerous persons making inquiries about carp.

Mr. Charles W. Smiley, chief of the division of records, during the year has had entire charge of the preparation of all matter for the printer, the correcting of the proofs of text and plates, and all else relating to the proper presentation of the several volumes, pamphlets, and circulars, as well as of their distribution to correspondents and applicants.

12.—THE WOOD'S HOLL STATION.

The importance of a station on the sea-coast, where the researches of the Commission into the ocean fisheries, the distribution and migrations of the fish, the character of their food, and all their associations, could best be prosecuted, has frequently been presented in the pages of the reports of the Commission, and reasons have been given at length from time to time why Wood's Holl, on the south coast of New England, and the extreme southwesternmost land of Cape Cod, had been selected. The report for 1883 furnishes a full statement of the measures taken to acquire a suitable locality, and the fact indicated that a suitable quantity of land was purchased by friends of science and presented to the United States, on condition of being used for the purpose in question; and this was supplemented by the donation by Mr. Joseph S. Fay of a large extension of the same water front. Also, that the title to the land was found by the Attorney-General of the United States to be satisfactory; and that the State of Massachusetts, under the administration of Governor Long, had ceded the necessary jurisdiction to the United States. The schedule of the buildings necessary for the work of the Commission was indicated, and the fact stated that two of the most important ones had been finished.

I now have to report that, Congress having made the necessary appropriation for the purpose, the erection of the laboratory building, an edifice 120 × 40 feet, has been begun and partly finished during the year; leaving for 1885 the construction of the coal shed and of a storage building, which it is hoped will be accomplished in 1885.

Owing to the fact that the foundations of the laboratory building had to be erected on mud, mostly covered at high water, unusual expenditures were required to secure a suitable foundation, making the cost considerably more than would otherwise have been the case. The natural difficulties, however, were overcome, and the superstructure was under roof by the end of the year.

Concurrently with the work on the Fish Commission building the construction of the adjacent harbor of refuge under the direction of Col. George H. Elliot, of the U. S. Engineers, and based upon an appropria-

tion in the river and harbor bill, was prosecuted, and the larger part of the stone work completed in the year. This, with the wooden wharves, when finished, will furnish every possible convenience for the work of the Commission, as well as answering the general needs of a harbor of refuge.

It is proposed to make Wood's Holl the general station for the vessels of the Commission, not only during the summer, but at other times when they are to be laid up; and where the necessary repairs can be made to the vessels by their own machinists, and thus a large amount saved to the appropriation.

The steam power required for the pumping of the water in the water-tower has been arranged to work a number of machine tools kindly lent by the Navy Department from the unused machinery of the Boston navy-yard, including lathes, planers, &c., thus aiding greatly in the facilities for repairs just mentioned.

Two artificial ponds for the propagation of the oyster were built under the direction of John A. Ryder on ground belonging to Dr. J. H. Kidder and Camillus Kidder kindly granted for the purpose. It is thought that much important experience will here be gained for the use of oyster culturists in general.

The western portion of the eel pond, immediately adjacent to the oyster pond in question, was granted by the selectmen of Falmouth to Mr. Joseph S. Fay, with the understanding that it was to be used for the experimental work of the Commission.

As in previous years at the various summer stations of the Commission, in addition to the specialists officially connected with its service, a number of naturalists visited the station for the purpose of utilizing the opportunities of research. Such specialists are always cordially welcomed, and every facility given them for the prosecution of their labors.

During the season, other visits were received from several eminent English men of science; among them Sir Lyon Playfair; Prof. Adam Sedgwick, of Cambridge; Prof. H. N. Moseley, of Oxford; Professor Hedden, of Dublin; and Prof. J. Cossar Ewart, of Edinburgh. They appeared to be much interested in the arrangements of the station, and on their return home made very eulogistic mention of what they had seen at Wood's Holl, and of the general plans and results of the work of the Commission.

As usual, the biological summer work, and especially that connected with the marine invertebrates, was prosecuted under the direction of Prof. A. E. Verrill, assisted by Prof. S. I. Smith.

The exploration of the Gulf Stream region was continued this season, under nearly the same conditions as in 1883, by the steamer Albatross, Lieut.-Commander Z. L. Tanner commanding. During the four trips, between July 20 and September 13, sixty-nine dredgings (at stations

2170 to 2238) were made. In most of these a large beam-trawl was used very successfully, even at great depths.*

Of these dredgings five were in depths between 2,000 and 2,600 fathoms (four successful), twenty were between 1,000 and 2,000 fathoms, twenty-four between 500 and 1,000 fathoms, eight between 300 and 500 fathoms, and twelve between 75 and 300 fathoms. Another trip has since been made to explore extensively the zone between 40 and 100 fathoms. On this trip about twenty-four additional dredgings were made, but the results are not yet worked out. The first trip was made while the steamer was on her way north from Norfolk, Va., and some of those stations were off the coast of Maryland, the most southern being in north latitude 37° 57′, but most of the others have been made in the region south and southeast of Martha's Vineyard, although several were a long way off the coast. The five stations in depths below 2,000 fathoms were more than half way to Bermuda, and nearly east of the coast of Virginia, between north latitude 36° 05′ 30″ and 37° 48′ 30″; and between west longitude 68° 21′ and 71° 55′.

The results are highly satisfactory, both in physical observations and zoological discoveries. Large numbers of additions have been made to the fauna, including representatives of nearly all classes of deep-sea animals. Many pelagic species were also secured in the surface nets, and especially in the trawlings. Among these there are some new forms, and many that have not previously been observed so far north in the Gulf Stream.

The most important economical application anticipated for the Wood's Holl Station is the propagation of codfish, under charge of Capt. H. C. Chester, the superintendent of the station. The first take of eggs was on November 14, and amounted to 3,000,000. These were treated, and many important facts ascertained in regard to their development. Unfortunately the work of dredging in the vicinity of the stone pier for the purpose of giving a proper depth for navigation kept the water in a turbid condition during all the time that the eggs of the cod were being hatched and militated very seriously against full success, a small percentage only of the fish being obtained. These, however, were planted in the vicinity. It is hoped that by another year these drawbacks will have passed away and that there will be nothing more to prevent the full realization of all my anticipations on this point.

13.—INVESTIGATIONS IN LONG ISLAND SOUND.

It is well known that the shallow waters adjacent to Long Island Sound, especially those of Great South Bay, abound in a great variety of fish, the flats becoming greatly warmed during the summer season

*It is but just to say that the unusual thoroughness and remarkable success of these explorations of the Gulf Stream region have been due to the great skill and untiring zeal and energy of Captain Tanner, who has personally superintended all our deep-sea dredging operations during the past five years. It is also proper to add that his efforts have been well supported by the other officers associated with him.

and constituting an acceptable abode for the young fish. It was from these waters, in great part, that Mr. J. Carson Brevoort, the eminent ichthyologist of Brooklyn, N. Y., derived most of his material, which he has kindly presented to the Smithsonian Institution.

In response to repeated suggestions from gentlemen specially interested in the subject, it was considered expedient to cause a careful examination to be made of the different kinds of fish occurring in these waters, and Dr. T. H. Bean was accordingly detailed for the purpose.

On September 30 Dr. Bean wrote from Patchogue as follows:

"We have enjoyed a highly gratifying day of collecting, and our list of species now foots up 53. The Lookout has helped us to increase our store by the addition of 14 species since it came in. The weather so far has been propitious and everybody seems satisfied. I am sorry that we did not secure the aid of the steamer much earlier, as we hoped to do. However, there are several accessions now of which I feel somewhat proud. We seined two examples of *Fistularia* to-day, besides a species of *Hemirhombus* (or *Platophrys*), and numerous examples of the ovate pompano *Trachynotus ovatus*. *Bairdiella* is quite common throughout the bay; so, also, is *Synodus fœtens*. Two species of anchovy occur—one of them very abundant—in the eastern portion of the bay, and the other not moving so far from the ocean inlet; everywhere these little fishes attract the bluefish, squeteague, silver gar, and other predaceous species. The silver sides (*Menidia notata*) are excessively abundant everywhere, and serve as food for the bluefish. I have been somewhat astonished to find one of the hakes (*Phycis tenuis*) well distributed in the bay, associated with the tomcod. The tomcod is much infested, in some places, with a lernæan parasite. *Gobiosoma* is very common. The tautog we find in greater numbers as we approach the inlet, and the same is true of the cunner. Young weakfish (squeteague) are universal, except in shoal water. Kingfish (*Menticirrus nebulosus*) are sufficiently numerous wherever we seine, but the young, from 1½ to 2½ inches or more in length, were taken in the surf to-day in larger numbers than I have seen before. The scup and the squeteague form the principal catch of the 7 pounds near the Fire Island light. Young sea-bass are much more abundant at Wood's Holl than we find them here. The white perch, a comparatively recent arrival in Great South Bay, is becoming gradually distributed, but we have not yet caught a single example in our seines. *Synodus fœtens* is a very common species here, reaching all parts of the bay visited by our nets. We do not find young menhaden, and the only clupeoids secured are an occasional half-grown menhaden, one hickory shad (*Clupea mediocris*) and one alewife (*C. vernalis*, probably). The big-eyed eel is one of our treasures."

14.—ICELAND HALIBUT FISHERY.

In the spring of this year three Gloucester fishing schooners made trips to the coast of Iceland to obtain flitched halibut and halibut fins. The flitched halibut are cured by smoking, and the fins are pickled. This is the first occasion of American fishermen visiting these grounds, and is somewhat noteworthy as the result of the interchange of views at the London Exhibition between our representatives and the Europeans. On his return from the London Exhibition, Captain Collins com-

municated to the Gloucester fishermen information relative to the localities, and as a result the vessels Alice M. Williams, Captain Pendleton; Concord, Captain Dago, and David A. Story, Captain Ryan, were fitted up. Their success was in every way satisfactory, and will probably lead to the continuance of the industry. A full account of the trips, obtained by Captain Collins from the vessels' logs and by conference with the masters, will be found in the appendix.

15.—INVESTIGATIONS OF THE SHAD FISHERIES OF FLORIDA, GEORGIA, AND SOUTH CAROLINA.

For the purpose of ascertaining the actual abundance of spawning shad in the Florida waters, with a view of establishing hatching stations, should the prospect be favorable, Mr. William Hamlen, one of the most experienced fish culturists of the Commission, proceeded to Florida, reaching Jacksonville on March 1, where he found very few fish, and received the impression that they had diminished so greatly in the Saint John's River as to indicate an impending exhaustion of the stock. He then went to the Saint Mary's River, where he found a larger supply of fish; and on March 4 obtained 13 ripe females from which 240,000 eggs were secured, but very little show for obtaining results of sufficient magnitude to warrant further effort. The same experience was encountered in the Satilla River, the diminution being equally marked as in the Saint Mary's.

Thinking it possible that the apparatus used by the fishermen in these rivers was not suitable for taking spawning fish, the steamer Fish Hawk, under command of Lieut. W. M. Wood, U. S. Navy, was ordered to Florida, and reached King's Ferry, on the Saint Mary's, on March 19. Nothing of any moment was accomplished, and the vessel returned to Washington. It was concluded that the best place for taking shad, for the purpose of artificial propagation, was the Saint Mary's River, between King's Ferry and the Brick Yard; and that if the logs in the river could be removed it was likely that enough shad could be taken for the purpose of artificial propagation.

Returning to Washington in the Fish Hawk, Lieutenant Wood stopped at Georgetown, S. C., for the purpose of investigating the fisheries in that locality. He found that the capture of fish is prosecuted entirely by gill-nets, and that very few ripe or spawning fish are taken, which, of course, would be quite natural in view of the saltness of the water.

16.—INVESTIGATION OF THE FISHERIES FOR WHITEFISH IN THE GREAT LAKES.

Desirous of ascertaining whether the artificial propagation of whitefish had made a perceptible increase, or, at least, prevented a diminution of the catch of the species within the last few years, Mr. Frank

N. Clark was instructed to visit as many of the stations on Lake Erie as possible, and to report the results of his inquiry.

The total number of young fish deposited by the U. S. Fish Commission, and the Ohio and Michigan fish commissions, amounted, from the spring of 1875 to the spring of 1882, to about 82,000,000; half of which were planted in 1881 and 1882, and would not enter into the number of fish taken.

Mr. Clark found it very difficult to come to any precise conclusion as to the ratio of abundance now and in earlier years, as the constant increase from year to year in the number of nets tends to make up for the diminished proportion of capture by each net. As the general result of the inquiry, Mr. Clark is decidedly of opinion that not only has the decrease been arrested, but that there has been a tangible and satisfactory increase, taking all conditions into consideration.

It is now proposed to collect systematically the statistics of the fisheries of the Great Lakes in 1885, and to show, by comparison with corresponding figures made by the census of 1880, more accurately what the change has been, whether for the better or the worse.

17.—MORTALITY OF FISH.

The occurrence of extended mortality among the fish, both of the fresh waters and of the sea, has been a subject of much interest, and the attention of the Commission has been specially attracted to the determination at least of the causes, even though they be so general in their action as to be apparently incapable of cure.

Several accounts have been given of the occurrence, at short intervals, of fish pestilences in the Gulf of Mexico, where for weeks at a time, in particular regions, the surface will be found covered with dead or dying fish of all kinds that inhabit the waters. Thousands of tons are estimated to be thus destroyed. Nothing satisfactory has yet been indicated as to the origin of this difficulty. The fish themselves do not appear to be diseased in any way. A correspondent of the Commission, however, has suggested that, owing to some unusual condition, the cold waters of the deeper parts of the Gulf are brought near to the surface, where they affect these fish, the sudden chill producing such a shock as to cause either death or temporary disturbance of health. The waters in which these occurrences take place are said sometimes to be discolored as if by the presence of microscopic forms of either animals or plants; and it is not impossible that a careful search, prosecuted by an expert on the spot, may solve the problem.

Mr. Philo Dunning, of the Wisconsin fish commission, called the attention of the U. S. Fish Commission to a fish pestilence in the Madison lakes during the summer, the perch especially suffering. It was thought that not less than 200 tons of dead fish came ashore, which were buried by the selectmen for the sake of preventing a pestilence. Every year there is more or less of this trouble, though not always re-

sulting in so great destruction. Various causes have been assigned in explanation of this mortality, some finding it in the parasitic leeches that are swallowed by the fish and which attach themselves to the intestines with fatal results, others to lack of oxygen in the water as a consequence of the intense heating of the shallow waters.

Desirous of settling this matter in the best possible manner, I requested Prof. S. A. Forbes, of Champaign, Ill., one of the most eminent biologists in the West, to proceed to Wisconsin and give personal attention to this subject. He unfortunately arrived after the close of the mortality, and was unable to ascertain anything definite on the subject. He, however, made preparations of the viscera of a number of the dead fish, and to his great surprise found that all thus affected gave evidence of the presence in the liver, spleen, and other organs, of innumerable micrococci. He has not yet determined whether this was the cause of the disease or its accompaniment, but proposes to continue the investigation.

B.—INQUIRY INTO THE HISTORY AND STATISTICS OF FOOD-FISHES.

18.—THE WORK OF THE FISHERY CENSUS OF 1880 AND ITS RESULTS.

In my report for 1882, pp. xliii–li, is given a brief account of the results of the joint investigation of the fisheries of the United States, undertaken in co-operation with the Superintendent of the Tenth Census. It was stated that a division of the material had been agreed upon, and that the manuscript of the report prepared for the census was already in his hands. Two years have passed since that time, and nothing has been accomplished by the Census Office toward the printing of this report, which being in the main statistical, is fast losing part of its value. Colonel Seaton, the present Superintendent of the Census, having requested that this manuscript, which he is unable to print, be so far as possible published in the report of the Fish Commission, he has returned a portion of the same, which will soon be put in the printer's hands, so as to form a section of the special quarto report ordered by Congress.

Progress in printing the quarto Fisheries Report.—The special quarto report upon "The Food-Fishes and Fisheries of the United States," ordered printed in 1882, is slowly being put in type, about 1,200 pages being already completed and a large number of illustrations engraved. The first section, devoted to the natural history of useful aquatic animals of the United States, with an atlas of 277 plates, has been entirely finished for some months, and its publication is awaiting the convenience of the Public Printer. The other parts of the report are ready, and it is hoped that in 1885 a great deal of progress will be made. The contents of the entire report will be, approximately, as follows:

THE FOOD-FISHES AND FISHERY INDUSTRIES OF THE UNITED STATES.

Introduction, including a general review of the fisheries and a statistical summary.

PART I.—The natural history of useful aquatic animals.
II.—The fishing grounds.
III.—The fishing towns, containing a geographical review of the coast, river, and lake fisheries.
IV.—The fishermen.
V.—The apparatus of the fisheries, and fishing vessels and boats.
VI.—The fishery industries, a discussion of methods and history.
VII.—The preparation of fishery products.
VIII.—Fish-culture, fishery laws, and fishery legislation.
IX.—Statistics of production, exportation, and importation. Summary tables.
X.—The whale fishery—a special monograph.
XI.—A list of books and papers relating to the fisheries of the United States.

Section II, "Fishing Grounds of North America," was also completed during the year, excepting the index, which will be ready in a few weeks. This section consists of VII + 144 pages, and will be accompanied by 17 maps.

19.—THE BLACK COD OF THE PACIFIC.

The value of the black cod of the North Pacific Ocean and the expectation of its coming value as an element of the American fisheries was dwelt upon in the preceding report. An elaborate report on this fish, prepared by Mr. James G. Swan, of Port Townsend, Washington Territory, will be found in the Bulletin of the Fish Commission for 1885, page 225. Nothing further has been done during the year in the way of developing the fishery or in introducing it into commerce.

20.—USE OF THE COD GILL-NETS.

It will be remembered that a few years ago the U. S. Fish Commission succeeded in inducing the fishermen of the east coast of Massachusetts to use the gill-nets with glass-ball floats, as employed by the Norwegians in the capture of the winter or spawning cod. At the present time the number of vessels using gill-nets exclusively is increasing, and at the same time the total yield of the fisheries; probably half, if not more, of all the fish taken now in the cod fisheries of New England are captured with the gill-net.

At the suggestion of Mr. Swan, of Port Townsend, the Commission furnished several cod gill-nets to parties working in Puget Sound, for the purpose of determining their availability in that locality. Unfortunately the rapid tide and the lack of skill in the use of the nets, caused them to drift on the rocks in the deep water and be lost.

The only drawback to the more extended use of gill-nets for the taking of cod and other sea fish consists in the rapidity with which the twine rots, probably owing to the amount of mucous rubbed off from the fish. In some cases it is necessary to supply a new set every four or five weeks.

As the total cost of nets used at the present time on the New England coast amounts to about $40,000 for the winter, the tax upon production is a very serious one. Various processes for the treatment of nets have lately been indicated and are now employed by the fishermen, some of them with apparent success, and it is to be hoped that the difficulty in question will soon disappear.

21.—INVESTIGATION OF THE OYSTER FISHERIES OF THE NEW YORK WATERS.

Investigations of the condition and availability of the oyster-beds of the State of New York have been in progress for some years under the direction of Mr. E. G. Blackford, one of its fish commissioners, and at his request the steamer Lookout was detailed for use in his explorations. The vessel was occupied for nearly two weeks in September in this connection, and the general results will shortly be published by Mr. Blackford in the reports of the State fish commission.

22.—LAW OF CONGRESS IN REGARD TO THE FISHERIES OF THE DISTRICT OF COLUMBIA.

The rapid decrease in the value of the fisheries of the Potomac River, especially of the shad, has induced some public-spirited citizens of Washington to take up the subject with a view of getting such Congressional legislation as might be necessary to secure the requisite measure of protection; and, after considerable debate, a law was passed which makes it illegal to use any form of net in the Potomac River within the District of Columbia for five years after the passage of the act.

CHAP. 316.—AN ACT to protect the fish in the Potomac River in the District of Columbia, and to provide a spawning ground for shad and herring in the said Potomac River.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after date of passage of this act, for a term of five years, it shall not be lawful to fish with fyke-net, pound-net, stake-net, weir, float-net, gill-net, haul-seine, or any other contrivance, stationary or floating, in the waters of the Potomac River within the District of Columbia.

SEC. 2. That any person who shall offend against any of the provisions of this act shall be deemed guilty of a misdemeanor, and upon sufficient proof thereof in the police court or other court of the District of Columbia, shall be punished by a fine of not less than ten dollars nor more than one hundred dollars for each and every such offense, and shall forfeit to the District his nets, boats, and all other apparatus and appliances used in violation of law, which shall be sold, and the proceeds of such sales, and all fines accruing under this act, shall be paid into the Treasury: *Provided*, That nothing in this act shall be construed to prohibit angling or fishing with the out-line, or to prevent the United States Commissioner of Fish and Fisheries, or his agents, from taking from said waters of the Potomac River, in the District of Columbia, in any manner desired, fish of any kind for scientific purposes, or for the purposes of propagation.

SEC. 3. That from and after three months from the date of the passage of this act it shall be unlawful to allow any tar, oil, ammoniacal liquor, or other waste products

of any gas-works, or of works engaged in using such products, or any waste product whatever of any mechanical, chemical, manufacturing, or refining establishment to flow into or be deposited in Rock Creek or the Potomac River or any of its tributaries within the District of Columbia or into any pipe or conduit leading to the same, and any one guilty of violating this section shall, on conviction, as provided in section 2 of this act, be fined not less than ten dollars nor more than one hundred dollars for each and every day during which said violation shall continue, to be prosecuted for and recovered as provided in the preceding section.

Approved March 2, 1885.

As there is every probability that the law will be enforced, so far, at least, as the use of nets is concerned, the experiment will furnish a fair test as to the utility of such protective measures. The law also prohibits the introduction of poisonous refuse of gas-works or other manufactories. The experiment of the protection of the broad waters of the Potomac referred to, will not probably be of much benefit unless strict measures are taken to prevent the discharges complained of. The incidental objections, aside from the injury to the fish, to the discharge of this oily or tarry matter consist of its foulness, and the extent to which it attaches itself to boats of all kinds, especially those belonging to the numerous Washington boating clubs.

C.—THE INCREASE OF FOOD-FISHES.

23.—BY PROTECTIVE MEASURES.

The idea is widely entertained that the U. S. Fish Commission has received from Congress some authority for enforcing measures looking towards the prevention of improper modes or times of capturing fish in American waters, and it is somewhat difficult to satisfy inquirers that the functions of the Commission are purely advisory, and do not include the power of either making or enforcing regulations. Its advice on such subjects, when asked, is, however, freely given. The only enactments by Congress on this subject thus far are those relating to the protection of fish in the waters in the District of Columbia.

In response to a request from the Board of Health of the District of Columbia, I directed Col. M. McDonald to make an investigation and report in reference to the pollution of the Potomac River in the limits of the District by the discharge into it of the waste products from the manufacture of illuminating gas.

The examination showed that a large amount of matter, presumably deleterious, is discharged into the river from the works of the Washington and Georgetown Gas Companies, the most serious source of pollution being the dark oily residuum coming from the regenerators employed in the establishment for the manufacture of gas from oil, this being used as an enricher of the gas from coal. The physical characteristics of this substance are such as must determine its general distribution

over the bed of the river in front of Georgetown and in lessening quantity as far down as the limits of the District extend. Its general distribution over the bed of the river may, and doubtless does, affect unfavorably the conditions of life for all those minute forms of life which have their nidus on the bottom, and which furnish the food of forms alike minute, which float or swim in the water above, and which afford appropriate sustenance to the young shad, herring, striped bass, &c. The pollution of the water may not exert a direct effect in driving the larger fish from the river, yet indirectly, by modifying unfavorably the conditions of life at the bottom, may, by destroying their food, render impossible the development and growth of the embryo fish, which must be nurtured in this area in numbers sufficient to compensate the annual drain made by the river fisheries.

In connection with the legislation now pending to limit or restrict net fishing in the District waters, it is deemed important to prohibit the discharge of waste products from the gas factories into the river, and I have so advised the Board of Health. The measures of legislation proposed and pending, if enacted into law, will doubtless exert an important conservative influence upon the shad and herring fisheries of the Potomac.

24.—SPECIES OF FISH CULTIVATED AND DISTRIBUTED IN 1884.

The species of fish and invertebrates receiving the attention of the Commission during the year, with the exception of the addition of a few of more or less interest, are the same as heretofore. Work has been prosecuted on a large scale in regard to only a few species; those receiving special attention, in addition to the several varieties of *Salmonidæ*, are the shad, the carp, and the goldfish. The scale of the operations on which the work has been conducted has, however, in many cases been much greater than heretofore; not only a larger number having been hatched out, but the area of distribution greatly extended.

The following is a list of the species included:

a. The Codfish (*Gadus morrhua*).
b. The Rockfish or Striped Bass (*Roccus lineatus*).
c. The Whitefish (*Coregonus clupeiformis*).
d. The Moranke (*Coregonus albula*).
e. The Grayling (*Thymallus tricolor*).
f. The Brook Trout (*Salvelinus fontinalis*).
g. The Lake Trout (*Salvelinus namaycush*).
h. The Saibling (*Salmo salvelinus*).
i. The California, Rainbow, or Mountain Trout (*Salmo irideus*).
j. The Atlantic or Penobscot Salmon (*Salmo salar*).
k. The Schoodic or Landlocked Salmon (*Salmo salar* subsp. *sebago*).
l. The Brown or European Trout (*Salmo fario*).
m. The Loch Leven Trout (*Salmo levenensis*).
n. The Quinnat or California Salmon (*Oncorhynchus chouicha*).
o. The Shad (*Clupea sapidissima*).
p. The River Herring (*Pomolobus æstivalis*).

q. **The Carp** (*Cyprinus carpio*).
r. **The Goldfish** (*Carassius auratus*).
s. **The Golden Ide or Orf** (*Leuciscus idus*).
t. **The Tench** (*Tinca vulgaris*).
u. **The Catfish** (*Amiurus nebulosus*).
v. **The Clam** (*Mya arenaria*).
w. **The Oyster** (*Ostrea virginica*).
x. **The American Lobster** (*Homarus americanus*).

a. **The Codfish** (*Gadus morrhua*).

The Wood's Holl Station.—The preparations for the hatching of codfish at Wood's Holl were not finished sufficiently in season to permit the work to be done on an extensive scale; but enough of experimental work was carried on at the station, under the direction of Capt. H. C. Chester, its superintendent, to give abundant promise of excellent results in the future. It is expected that, with the completion of the preparations, another winter will witness the successful progress of the work on a very large scale.

The construction of a schooner containing a well for the transportation of live fish will add greatly to the success of the work. Much of the anticipated result will depend upon the ability to obtain breeding fish in sufficient quantity to keep the apparatus in full activity, and it is hoped that Congress will make the necessary appropriations for such a vessel.

b. **The Rockfish or Striped Bass** (*Roccus lineatus*).

The Weldon (North Carolina) Station.—The greatly increased catch of small rock by the introduction of pound-net fishing in our rivers and fresh-water sounds indicates the necessity at an early day of making provision to compensate by artificial propagation for the drain upon the supply.

The experimental work conducted during the present season at Weldon, N. C., jointly by the U. S. Fish Commission and the North Carolina Commission of Fisheries, under the direction of S. G. Worth, superintendent, assures us that we now have at our command the methods and apparatus necessary to handle successfully this class of eggs whenever it is necessary to resort to artificial propagation in order to maintain or increase the supply.

The interesting report of Mr. Worth, which will be found in the Bulletin for 1884, pages 225–228, gives full details of the organization and conduct of the work, the method and apparatus employed, and the results attained. The total number of impregnated eggs obtained was only 2,420,000, but by occupying the station at the beginning of the season and providing suitable facilities for collecting the spawn, it is probable that eggs can be obtained in any number desired. The apparatus employed was the automatic jar now in general use in the shad work, the manipulation of the eggs being difficult, however, on account of the greater buoyancy of the eggs of the striped bass. The pro-

portion of eggs incubated which hatched was 52 per cent and the number of fry planted in the Roanoke at Weldon was 280,500.

c. **The Whitefish** (*Coregonus clupeiformis*).

The Northville Station.—The work at this station, which continued under the supervision of Mr. Frank N. Clark, was carried on much as during the previous year, but on a much more extensive scale. The propagation of whitefish is the principal object of the station, and this work being greatly increased, a corresponding increase in the facilities for handling the eggs and young fish was required. The equipments of the hatchery were rearranged, more hatching-jars were introduced, several additional tanks were placed in a building near the hatchery, and an elevated reservoir was constructed from which the hatching apparatus was kept amply supplied with water.

The winter of 1884–'85 was an extremely severe one in Northville; consequently the hatching period was several weeks later than usual, and the distribution of young fish, which generally begins about February 20, did not commence this year until April 1. The weather during the period for taking the eggs, November 13 to December 1, was very favorable most of the time on Lake Erie; but a severe storm on Lake Huron, November 6, seriously interrupted the work there. The summer and fall catch of whitefish in Lake Erie was much greater than for several seasons. This was largely due to the work of propagation carried on by the various fish commissions, as this lake was more largely planted than others with whitefish; and the fishermen are now becoming convinced of the practical value of such work.

The penning of whitefish was successfully carried on in the Raisin River, where the fish were kept in crates alongside the piers in the river, about one-quarter of a mile from Lake Erie. To these crates the fish were towed from the pound-nets in the lake in a "live-car," at the rate of about 5 miles an hour, always with safety to the fish. A heavy storm in the latter part of November blew so much of the water from the river that the fish had to be disposed of; but this circumstance is unprecedented, and not likely to occur again. The penned fish were handled very successfully. The first eggs were taken November 13, and the greatest number taken in one day was 750,000. The temperature of the water in the crates ranged from 36° to 46° Fahr. This plan of penning the fish was tried also at Alcona, on Lake Huron, with much promise of success should the place be fitted up properly for this purpose.

The shipments of whitefish eggs to various States and to foreign countries were much larger than before and generally very successful, the losses being almost nothing. During the shipping season, which lasted from December 24 to March 10, 31,000,000 eggs were furnished by Northville. Two million were sent to the Deutsche Fischerei-Verein of Germany, half of which were lost because of bad handling

on the steamer; 500,000 to Switzerland, where their safe arrival was reported by Col. Emil Frey, Swiss minister to the United States; 250,000 to the National Fish Culture Association of England, which reached their destination in excellent condition; 1,000,000 to Australia, which, after reaching Sydney in good condition, were nearly all lost in transferring them to Melbourne; 1,750,000 to the New Orleans Exposition; and the remainder were distributed among seven States and Territories, and to the U. S. Fish Commission at Washington.

The distribution of the young fish was not so successful relatively as before, as the fish had been too crowded at the hatchery, owing to the lateness of the hatching season, and were consequently weak. On experiment, also, it was found that large and open cans are safer for large shipments of fry than smaller and closed cans. From Northville fifty million fish were planted, largely in Lake Michigan and adjacent waters.

Somewhat extensive operations were carried on at this station in lake trout, brook trout, rainbow trout, grayling, and Loch Leven trout, which are spoken of under their proper heads.

The Alpena Station.—Much that has been said about success, &c., at the Northville station applies also to this station.

No eggs were distributed from Alpena, but 38,000,000 fish were successfully hatched and planted, chiefly in Lake Huron.

The eggs from these two stations came from the fisheries of Lakes Erie and Huron and the north shore of Lake Michigan, 103,000,000 coming from Lake Erie alone. In all, 155,000,000 were received; 31,000,000 were shipped away, and 88,000,000 hatched and planted.

The Cold Spring Harbor Station.—In 1883, 1,000,000 eggs were received from the Northville station and hatched with a loss of only 4 per cent, and 600,000 fry were planted in ponds near Riverhead and Cold Spring Harbor.

In 1884, there were received also 1,000,000 eggs, of which number 400,000 fry were planted in Great Pond, near Riverhead, 375,000 in Lake Ronkonkoma, near the center of Long Island, and 75,000 in a mill-pond at Cold Spring Harbor.

Central Station.—In December, 1884, or about the first of January, 1885, two shipments of 1,000,000 eggs each were received from the Northville station in excellent condition.

These produced 1,775,000 fry, which were disposed of as follows:

Sent to the Fish-Cultural Exhibit, New Orleans Exposition	200,000
Planted in Potomac River at Sir John's Run	1,250,000
Planted in Potomac River at Great Cacapon	325,000
Total	1,775,000

d. **The Moranke** (*Coregonus albula*).

This fish is held in very high esteem in Germany, in consequence of which Herr von Behr wrote on the 25th of December that he would send 50,000 eggs to New York for the United States Fish Commission. He

states that it is a fine fish, occupying deep lakes in the north of Germany, and grows to a weight of 1½ pounds. It is never found in German lakes of less depth than 50 feet, and never in running water. It feeds on small crustaceans, worms, and mussels, coming to the surface only at night, especially warm summer nights. In early winter it spawns in shallow water, generally performing this act during the night. Each female bears from 2,000 to 5,000 eggs, which sink to the bottom and adhere to aquatic plants. It is usually caught in large numbers with nets and seines, and brought to the market either fresh or smoked. It is highly esteemed on account of its delicate flavor.

e. **The Grayling** (*Thymallus tricolor.*)

The Northville Station.—The grayling is a famous game fish which seems to be steadily diminishing in number, hence it is necessary that measures be taken for its protection and propagation. The work of the past season was largely experimental, as there was no exact knowledge regarding the spawning habits of this fish. Many obstacles, also, had to be encountered and overcome, such as deep snow, swift currents, and the great number of logs that were being sent down the Manistee and Au Sable Rivers in Northern Michigan, from which the eggs were obtained; while the fish that furnished the spawn were caught by hook-and-line fishing. Twenty thousand eggs were received, and 5,000 were shipped to the Central Station at Washington, while nearly 12,000 were hatched, and those that lived were retained at the Northville Station for breeding purposes. The period of incubation was found to be from 14 to 20 days, with a water temperature ranging from 50° to 62° Fahr. The hatching was successful, about 75 per cent of the eggs hatching out; but fully 90 per cent of the fry died within a couple of weeks, as most of them refused to take food. The few hundred that lived grew rapidly, far exceeding the size of trout of the same age.

With the experience gained this season, the work of another season would doubtless be more successful. It is suggested, however, that a better way would be to catch the fish during the autumn, when the rivers are free from logs, and to keep them in a suitable place until their spawning time, which seems to be about the middle of April.

The Wytheville Station.—On May 1, 1885, 5,000 eggs of the grayling were received at the Wytheville Station. These were hatched and produced 4,075 young. Heavy mortality occurred after hatching, and on May 1, when the young were transferred from the hatching troughs to the rearing ponds, only 2,557 remained. These will be retained at the station and the attempt made to rear them in confinement.

f. **The Brook Trout** (*Salvelinus fontinalis*).

The Northville Station.—The eggs were obtained from the breeding stock at the Northville ponds, more being taken from fish two and one-half years old than from those of any other age. The first eggs were taken October 12, and the last January 5. In all 326,850 eggs were

obtained, and 170,000 were shipped away; 40,000 being sent to the Deutsche Fischerei-Verein, in Germany, where they arrived in good order; 25,000 to the National Fish Culture Association, of England, reaching there in excellent order; and the rest being distributed among nine States. Of the 20,000 fry obtained, 4,000 were kept at the station for breeding purposes, and the remainder were planted in various streams in Michigan.

The Cold Spring Harbor Station.—In 1883, 150,000 eggs of the brook trout were received from the Northville Station, which yielded 122,000 young fish for distribution.

In 1884, 6,000 eggs were handled, yielding 5,000 fry, which were planted at points on Long Island.

g. **The Lake Trout** (*Salvelinus namaycush*).

The Northville Station.—There was a greater supply of the eggs of this fish than usual, the larger proportion being obtained from runs of fish on the coast reefs of Lake Huron near Alpena. Formerly the fishermen objected to the eggs being taken if the young fish were to be returned to the Great Lakes, under the apprehension that they would prey upon the young of the whitefish; but now the increased prices obtained for these fish have influenced the fishermen to favor artificial propagation. There were received at Northville 465,000 eggs, all of which came in good condition. Of this number, 345,000 were shipped away; 30,000 being sent to the National Fish Culture Association, of England, which they reached in excellent condition; and 5,000 to the New Orleans Exposition, the rest being distributed among fish commissioners of various States; while 65,000 fry were hatched and planted in neighboring parts of Michigan and Indiana.

Central Station.—Sixty thousand lake trout eggs were received from the Northville Station on December 25, 1884, arriving in prime condition. They yielded for distribution 52,000 fry, which were planted in the Potomac River, at Sir John's Run, and in the Monocacy, at Frederick City Junction.

The Wytheville Station.—Forty thousand ova of the lake trout were received from Northville on January 30, 1885. These yielded 29,000 fry for distribution. A few hundred were retained for rearing in ponds, and the rest planted in Reed Creek, a tributary of New River, in Wythe County, Virginia, on April 16, after being fed for several weeks in the hatching troughs.

h. **The Saibling** (*Salmo salvelinus*).

Reference has been made in previous reports to the receipt of several lots of the saibling, their delivery in 1881, and their transfer for subsequent treatment to the fish commissioners of New Hampshire, at Plymouth. As already stated, they seem to take well to their new surroundings, and the first eggs were obtained on December 3, 1883. The New Hampshire commissioners continue their work with this fish, and,

by impregnating the eggs of brook trout with saibling milt, secure a hybrid which may possibly be of value. It is not thought that the saibling is superior in value to our own native fish, although experiments upon both the pure species and the hybrid will be continued.

i. The California, Rainbow, or Mountain Trout (*Salmo irideus*).

The McCloud River Station.—Mr. Livingston Stone retains the general supervision of this station, but Mr. Loren W. Green was immediately in charge. The spawning time seems to come a little later each year. This season it lasted from December 18, when 12,300 eggs were taken, to May 28, when 8,000 were obtained; and at this last date a number of the females had not yet spawned, though the spawning season for the males was entirely over. The eggs were slower in maturing in the fish than usual, were of inferior quality, and about 200 less in number to the fish than in former years. Much of this may be attributed to the scarcity of food in the river during the fall, as the food supply for the McCloud River was much diminished, owing to the blasting operations near the mouth of Pitt River (into which the McCloud empties) by the Central Pacific Railroad Company.

During the latter part of January a heavy fall of rain caused a rapid rise in the river, and a landslide on the creek which supplies the trout ponds made the water very muddy and killed 35,000 eggs in the hatching troughs, despite the utmost efforts to protect them.

Notwithstanding the difficulties experienced this year, 315,225 eggs were taken; of which number, 125,000 were sent to Washington, nearly 60,000 were lost, 35,000 were sent to Minnesota, Iowa, and Nebraska; some were hatched and returned to the McCloud River; and about 21,000 were hatched and the young fish kept at the station for breeding purposes.

The Northville Station.—There was a marked improvement in the quality of the eggs which were obtained from the breeding stock at the Northville ponds. In former years from 75 to 90 per cent of the eggs were lost, but this season more than half were good. As the breeding fish were fed much less than usual, this is thought to account for the improvement. The spawning season began on January 9, and ended April 24; and many of the later lots of eggs taken turned out as high as 90 per cent good. A few eggs were taken also from two-year-old trout, for the first time at this station.

During the season 111,100 eggs were obtained from 126 fish. The mortality during incubation was very large, only 47,500 eggs being available for distribution. Small allotments were sent to the Deutsche Fischerei-Verein (Germany), to the National Fish Culture Association (England), and to the Howietoun hatchery (Scotland), some to the New Orleans Exposition, and the rest were distributed to the fish commissioners of Iowa, Michigan, and Minnesota; and 12,000 fry were hatched and planted in a stream near Northville. The eggs sent to Germany

were not properly cared for on the passage, and were all lost. Those to England were duly received in good condition, hatched with a very low rate of mortality, and planted in the fish-culture establishment at Delaford Park; and those to Scotland arrived in good order.

The Cold Spring Harbor Station.—From four lots of eggs received in 1883, 75,000 eggs in all, only 26,200 fry were obtained. These were planted in various waters of New York. The number handled in 1884 was only 10,000, which were planted in streams near the station.

This is a fish that, for some reason, does not do well at this station. During the summer of 1884, though plentifully fed, they did not grow much, and they died in great numbers.

This species is a quick-growing fish and not very sensitive to warm water, and in these respects is superior to our brook trout.

Central Station.—One hundred and forty-seven thousand five hundred eggs of the rainbow trout were received from the McCloud River Station during the months of January, February, and March, 1885. The packages were opened, their condition ascertained, repacked, and the eggs distributed as follows:

To Wytheville Station	113,000
To the Fish-Cultural Exhibit, New Orleans Exposition	5,000
To the Maryland Commissioner of Fisheries	5,000
To Cold Spring Harbor Station, New York	22,500
To H. I. Pierce, Winsted, Conn	2,000
Total	147,500

No eggs of this species were hatched at Central Station during the season.

The Wytheville Station.—This station was first occupied in the winter of 1881–'82 with the object of establishing a center for the breeding and rearing of Salmonidæ for stocking the headwaters of those streams in Pennsylvania, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Tennessee, Georgia, and Alabama, which rise in the Appalachian region and flow into the Atlantic and the Gulf of Mexico.

A notable feature of the work of the year is the stocking of a number of the streams of the South Atlantic and Gulf Basins with two-year-old California trout. The California trout reared at the station from eggs brought from McCloud River, California, spawned for the first time in December, 1884.

With the close of the year, therefore, we have this station inaugurated as a producing as well as a hatching and distributing station. The fish-cultural work hereafter will be mainly directed to the breeding and rearing of the California trout for stocking Appalachian waters; and as it is not proposed to distribute the fry bred at the station until they are at least one year old, it will require a very extensive system of ponds to meet the requirements of the work. Detailed plans for these and for a new hatchery have been already perfected.

The total number of eggs incubated during the season was 161,000. Of these, 113,000 were obtained from the McCloud River Station, and 48,000 from breeders at the station, reared from eggs obtained in the winter of 1881–'82 from the California Station.

The number of young fish produced was 121,417, which was reduced by casualties of various kinds to 103,400 fish on May 1, when the fry were transferred from the hatching troughs to the ponds. It is not contemplated to distribute them until the late winter and spring of 1886, when they will have attained such size as to be comparatively safe from the attacks of other fish.

A large distribution of yearling California trout was made to streams in Pennsylvania and a number of streams and ponds in Virginia, Tennessee, Alabama, and Georgia.

The total distribution was as follows:

To streams in the vicinity of Philadelphia, Pa	fry	1,500
To streams in Pennsylvania, distributed under direction of State commissioner	yearlings	5,900
To streams in Western North Carolina	do	2,000
To Tate's Run, near hatchery	fry	2,500
To Shenandoah River, Virginia	yearlings	2,100
To Warrior River, Alabama	do	1,000
To Coosa River, Rome, Ga	do	1,000
To private ponds in Pennsylvania and Tennessee	do	250
Total		16,250

j. **The Atlantic or Penobscot Salmon** (*Salmo salar*).

The Bucksport Station.—Mr. Charles G. Atkins continues in charge of this station, the operations being conducted, as formerly, by the U. S., the Maine, and the Massachusetts Fish Commissions. The breeding salmon, as heretofore, were purchased from the Penobscot River fishermen, beginning on May 31 and ending on July 5. In all, 568 salmon were obtained, of which number 472 were placed alive in the inclosure of part of Dead Brook, 50 were turned into a large inclosure in Eastern River, and 46 died while being transported. In the autumn 393 were recaptured in Dead Brook, and 39 in the river, being about 83 per cent of all those deposited alive, and about 76 per cent of all those obtained. The fish were recaptured in Eastern River by means of traps of netting set at each end of the inclosure; and about the same number were taken at each point, thus seeming to indicate that salmon are as likely to descend as to ascend at the spawning season.

The fish at spawning were of much smaller size than those of 1883, averaging nearly 10 pounds in weight and being about 31⅓ inches in average length, but not differing much from the average of other years; 42 per cent were males, and 58 per cent females. In all, about 1,935,000 eggs were obtained, while during development about 119,000 were lost. Of the good eggs 78,000 were hatched on account of the U. S. Fish Commission, and the remainder, 1,730,000, were sent away. Shipments

were made during January and February of 1885 with the usual success; 30,000 were sent, through Mr. Fred Mather, of the Cold Spring Harbor Station, to England, where they were received by the National Fish Culture Association in excellent condition, the loss during transportation being less than 1 per cent.

The shares of the eggs allotted to the United States and to the various States interested are enumerated in Mr. Atkins's report in the Appendix.

The Cold Spring Harbor Station.—During the spring of 1883, 295,000 fry from this station were planted in the headwaters of the Hudson and Salmon Rivers, being the fish resulting from 350,000 eggs received from the Bucksport Station.

In 1884, 500,000 eggs were received from the Bucksport Station; and 448,700 fry were hatched, and 428,200 planted, mostly in the headwaters of the Hudson River.

Central Station.—On February 12, 1885, 10,000 eggs were sent from the Bucksport Station, and received in first-class condition. From these were produced 9,796 young, which were planted in Palmer River, Rhode Island, May 8, 1885.

k. The Schoodic or Landlocked Salmon (*Salmo salar* subsp. *sebago*).

The Grand Lake Stream Station.—The work at this station was very successful, showing a considerable gain over that of 1883. Mr. Charles G. Atkins continues in charge; but the work of the spawning season was by him turned over to Mr. H. H. Buck, with several experienced assistants. The fishing lasted from October 30 to November 22, and resulted in the capture of 1,186 fish, 808 being females and 378 males. There was a marked increase in size, as well as a gain in number, over the catch of 1883, as in 1884 the males averaged 4 pounds and the spawning females averaged 4.11 pounds in weight.

This station is jointly operated by the U. S. Fish Commission and the State commissions of Maine, Massachusetts, and New Hampshire, and the eggs obtained are allotted *pro rata* to the different parties contributing to the expenses of the station.

Total production of eggs for the season	1,820,810
Losses during incubation	254,410
Available for distribution	1,566,400
Hatched at the station and returned to Grand Lake Stream	397,400
Available for pro rata distribution	1,169,000

Which were allotted as follows:

To U. S. Fish Commission	608,000
To Maine Fish Commission	234,000
To Massachusetts Fish Commission	187,000
To New Hampshire Fish Commission	140,000
	1,169,000

Those allotted to the U. S. Fish Commission were assigned as follows:

To the Deutsche Fischerei-Verein, Germany	40,000
To the National Fish Culture Association, England	30,000
To Scotland, Tay Fishery Board and Howietoun hatchery	20,000
To Fish-Cultural Exhibit, New Orleans Exposition	5,000
To Central Station, Washington	10,000
To State commissioners and individual applications	503,000
	608,000

In general, these eggs reached their destinations in good condition and were successfully hatched and planted. Full details regarding the fish caught, their size, and the shipments of eggs may be found in tables appended to the report of Mr. Atkins.

The Cold Spring Harbor Station.—In 1883 and 1884 there were received at this station 141,500 eggs of this fish from the Grand Lake Stream Station; and about 125,000 fry were distributed in various streams and ponds of New York.

Central Station.—March 24, 1885, 10,000 eggs were sent from the Grand Lake Stream Station, and received in excellent condition. These yielded 7,000 fry, which were disposed of as follows: Retained for the aquaria at Central Station, Washington, D. C., 2,000; planted in the Shenandoah River at Waynesborough, Va., 5,000.

l. **The Brown or European Trout** (*Salmo fario*).

The Cold Spring Harbor Station.—Early in 1883 a lot of eggs of this species was sent to Mr. Mather as a personal present by Herr von Behr, president of the Deutsche Fischerei-Verein. Most of those kept at this station died, but those sent to the Northville Station and to the station of the New York Fish Commission at Caledonia were reported as doing well. In 1884 Herr von Behr sent an additional gift, this time to the U. S. Fish Commission, in care of Mr. Mather, and a lot of 10,000 was received from England. These did better than those of 1883, and many were distributed to various New York waters.

On the 21st of February Mr. Mather forwarded to Washington 2,000 of the large kind of *Salmo fario* and 9,000 of the small variety. These were transferred to the Wytheville Station to be hatched.

It was found by experience that this fish has a strong tendency to leap out of the water when disturbed or when placed in new waters: and many died by jumping out on banks even 2 feet high, and remaining there to perish. This European brook trout has larger scales than our brook trout, and probably can be successfully acclimatized in the streams along our Atlantic coast.

The Wytheville Station.—Eleven thousand eggs of this species (2,000 of the large variety, and 9,000 of the small variety) were sent to this station from the Cold Spring Harbor Station, by way of Washington, in February, 1884. These were hatched with fair success, but all died before beginning to eat.

m. **The Loch Leven Trout** (*Salmo levenensis*).

The Northville Station.—One hundred thousand eggs of this species were received in excellent condition on January 7, 1885, from Scotland, having been sent by Sir James Gibson Maitland, of the Howietoun fishery, Stirlingshire, and repacked by Mr. Fred Mather, of Cold Spring Harbor, N. Y., by whom all shipments of eggs to and from Europe were skilfully and successfully handled. Fifty-five thousand of the eggs were distributed to the commissioners of New Hampshire, Iowa, Minnesota, and Maine. The loss of the eggs in hatching was very slight, and only a few of the fry died in the tanks. Of the 43,500 that were hatched at Northville, 36,500 were planted in various streams in Michigan, and 7,000 were retained at the hatchery for breeding purposes.

n. **The Quinnat or California Salmon** (*Oncorhynchus chouicha*).

Active operations at the McCloud River Salmon Station were suspended this year for reasons which will be found in Mr. Stone's report in the Appendix. The property of the Commission at this point was placed under the care of Mr. Robert Radcliff.

o. **The Shad** (*Clupea sapidissima*).

The Fort Washington Station.—This station was continued in charge of Lieut. William C. Babcock, U. S. Navy, under much the same general conditions as in 1883. A small frame house was built near the wharf as an office and to preserve the eggs from bad weather and it still remains as an improvement to the station. Arrangements were made early in the season with a gang of seine haulers to fish the seine on shares, giving the spawn taken to the Fish Commission, which furnished the outfit. Tent Landing, Chapman's Point, White House, and Ferry Landing were visited regularly during the season; and a number of gill-net fishermen also furnished eggs. The owner of Moxley's Point refused to allow the Commission to take spawn on his fishing-shore, as he expected a more liberal offer for the privilege. A steam-launch was furnished by the Navy Department. From April 9 to May 1 this launch made daily trips to the fishing-shores as far down as Chapman's Point, but this was found to be a severe task for so small a boat, and during May the Fish Hawk aided in this work.

The station was fitted for service on April 7, and the first eggs (45,000 in number) were taken on April 14, but the temperature of the water was too low for their successful development. About the middle of May severe rains and the resulting high water and currents disturbed the fishing considerably; but in general the conditions were more favorable than during the preceding season. On May 27, nothing having been caught for several days, the station was closed for the season, a total of 19,000,000 shad eggs having been taken. The seine hauled by the Fish Commission was successful, as it alone furnished 6,000,000 eggs, and supplied an abundance of fish for the food of the men. Experiments were tried in penning shad, with the same results as in 1883,

namely, that males can be kept for five or six days in good condition, but that females usually die after two or three days. Penning male shad towards the close of the season, when the gill-nets catch only females, may be advisable, and save many millions of eggs.

Herring were numerous about the station towards the middle of May, but after May 16 they disappeared. One lot of herring eggs (3,000,000 in number) was taken, but for some reason they failed to hatch.

Because of their former experience the men were more successful than before. Some valuable recommendations in regard to this station are found in Lieutenant Babcock's report.

Fish Hawk assistance.—On May 1 the steamer Fish Hawk, Lieut. W. M. Wood commanding, left the navy-yard at Washington for Fort Washington and vicinity to assist in the shad propagation.

From May 2 to May 26 the steam-launch visited Chapman's Point, Pomonkey, and other fisheries, from which were obtained about 3,000,000 shad eggs. About 800,000 of these were hatched; 400,000 fish being placed in the Potomac near Marshall's Point, and 400,000 sent to Central Station at Washington.

The sudden fall in the temperature of the water on the 7th of May is thought to have killed about 200,000 eggs. The remaining 2,000,000 eggs were shipped to the Central Station at Washington. On May 20 the fishery at White House Landing suspended fishing for the season, followed by Chapman's Point fishery on the 21st, and on May 27 the Fish Hawk returned to Washington, D. C.

Battery Station.—On the opening of navigation in March, 1884, William Hamlen, one of the experts in fish and oyster culture of the Commission, who had previously commanded the Lookout, was assigned to duty as superintendent of this station. During the early spring the force at the station was employed in clearing the seine-haul of obstructions and getting ready for the fishing season.

Preparations having been completed on the 14th of April, the fishing equipment was turned over to Messrs. Benjamin R. Sheriff & Co., with whom arrangements had been made for operating the seine during the season, this firm having bound itself to haul the seine under the general direction of the superintendent, and furnish all the ripe fish taken, for the uses of the Commission.

The season was very backward and the fishing was much interrupted by heavy winds and freshets. During the season the experiments of penning the immature shad in the pool were conducted, but not with very satisfactory results. It was, however, demonstrated that the male shad could be kept for a much longer period and with much better success than the females.

Towards the end of May, the fish having become very scarce, operations were suspended, with the result of the production of 1,839,000 of shad, which were turned loose in the waters immediately contiguous to the station, and 840,000 shipped to the tributaries of the Chesapeake Bay.

During this season coal-bins and an addition to the hatching-house were erected, together with a tower for the reception of two tanks for increasing the supply of water.

Congress having made an appropriation for the construction of additional piers and breakwaters, a pier or embankment running east and west from the station, about 495 feet, was built for the protection of the boats and to form, with a connecting pier from the westerly end of the dike already constructed, a pond for the culture of carp. This work was prosecuted under the United States Engineer Department.

Alongside the original wharf an additional space of 32 feet by 100 was filled in to give greater wharf facilities and on which to erect additional buildings. On this space has been located an iron oil-house, 10 feet square, in which all the paints, oils, and inflammatory materials are kept, as being the most remote point from the buildings.

As it has been found advisable to make this station the repair-shop and store-house for the launches, boats, &c., operating in the Chesapeake Bay region, the addition to the hatching-house was converted during the winter and summer months into a machine-shop. During the summer and winter the launches, boats, &c., were overhauled and placed in condition for future operations; and various minor improvements were made at the station to increase its facilities for accommodating the hatching apparatus, equipment of the steamers, &c., when not employed in hatching operations.

During the fall a portion of the work constructed by the Engineer Department was destroyed by a violent storm, and the engineer force having removed, as the appropriations were not adequate for the completion of the work, the damage was repaired by the Fish Commission force at the station.

Central Station.—The eggs obtained at the collecting stations on the Potomac River are forwarded to this station, where they are hatched and whence they are conveniently distributed by rail in all directions. The total number of fish and eggs received in good condition at the station for the season was 19,161,000, which were obtained as follows:

From Fort Washington Station, 17,926,000 eggs; from steamer Fish Hawk, 865,000 eggs and 370,000 fry.

The number of fry produced for the season was 13,200,000.

The following summary of production and distribution will be of interest in this connection:

Station.	Eggs obtained.	Fish hatched.
Battery (Havre de Grace, Md.)	4,617,500	2,679,000
Steamer Fish Hawk (Potomac River)	3,000,000	800,000
Fort Washington (Potomac River)	19,000,000	
Central Station (Washington, D. C.)		13,200 000
Total	26,617,500	16,679,000

Distribution of young shad through Central Station in May and June, 1884.

Date.		Place of deposit.	Stream stocked.	No. of fish.
1884.				
May	2	Near Woodstock, Va	Shenandoah River	*250, 000
	4	Frederick City, Md	Monocacy River	*365, 000
	6	Rappahannock Station, Va	Rappahannock River	*390, 000
	6	Charlottesville, Va	Rivanna River	*250, 000
	6	Rome, Ga	Etowah River	*407, 000
	7	Riverton, Va	Shenandoah River	*300, 000
	8	Taylorsville, Va	Little River	*300, 000
	8	Near Greenville, Ala	Patsaliga River	*200, 000
	8	Evergreen, Ala	Sepulga River	*180, 000
	9	do	Burnt Corn Creek	200, 000
	9	Milford, Va	Mattapony River	*300, 000
	10	Brewton, Ala	Murder Creek	*180, 000
	11	Charlottesville, Va	Rivanna River	*300, 000
	11	Toccoa, Ga	Savannah River	*750, 000
	11	Greenville Court House, S. C	Saluda River	*750, 000
	13	Seaford, Del	Nanticoke River	†250, 000
	15	Glens Falls, N. Y	Hudson River	*1, 217, 000
	17	Poplar Bluff, Ark	Black River	*400, 000
	17	Waynesborough, Va	Shenandoah River	*250, 000
	17	At the Little Falls, Md	Potomac River	‡370, 000
	17	Newport, Ark	White River	*400, 000
	17	Little Rock, Ark	Arkansas River	*360, 000
	20	Luray, Va	Hawk Bill Creek	*300, 000
	21	Near Norwood, Va	Tye River	*597, 000
	21	Maiden's Adventure, Va	James River	*597, 000
	22	Mount Jackson, Va	Shenandoah River	*230, 000
	22	Chestertown, Md	Chester River	†250, 000
	23	Woodstock, Va	Shenandoah River	*250, 000
	23	New Milford, Conn	Housatonic River	*975, 000
	28	Quitman, Ga	Withlacoochee River	*460, 000
	28	Thomasville, Ga	Ochlockonnee River	*460, 000
June	5	East Bridge, Ariz	Colorado River	*953, 000
	9	Somerville, N. J	Raritan River	†80, 000
		Total		13, 521, 000

* Product of Central Station. † Product of Battery Station. ‡ Product of steamer Fish Hawk.

The distribution covered by the above table summarized by river basins was as follows:

To the Colorado River of the West, tributary to Gulf of California	953, 000
To the Mississippi River and minor tributaries of Gulf of Mexico	3, 247, 000
To rivers of the South Atlantic slope	1, 500, 000
To the Chesapeake and its tributaries	5, 549, 000
To the Hudson River, New York	1, 217, 000
To the Housatonic River, Connecticut	975, 000
To the Raritan River, New Jersey	80, 000
Total	13, 521, 000

The Cold Spring Harbor Station.—In May, 1884, 80,000 eggs were sent to this station from Washington, for the purpose of experimenting with hatching them in spring water. The eggs were placed in McDonald hatching-jars, with the water at an average temperature of about 60° Fahr.; and nine days after their receipt 78,000 fry were successfully planted in the Nissequague River, on Long Island. The loss of the eggs was very slight, being only 615, while only about twice as many of the fry died before planting. Owing to the coolness of the spring water, no fungus was found on the dead eggs. It should be stated, however, that a similar trial, which was made later, proved a failure. A fuller account of these experiments will be found in the Bulletin for 1884, page 198.

Results of planting shad in Georgia waters.—General Young, of Georgia, states that the plant of shad made in recent years in the Oostenaula

and Etowah Rivers has been a great success, and that a great many shad were taken out of these two rivers last spring and the year before.

Concerning the increase in shad in this State, due to propagation, Dr. H. H. Cary states in his report to the Commissioner of Agriculture for 1883 and 1884 that:

"In 1880, 1,000,000 shad fry were planted in the waters of Georgia, and in 1881, 1,800,000. This was the work of the United States Fish Commission. In three years after the planting they returned to find their spawning-grounds. Of the planting of 1880, 400,000 were released in the Chattahoochee, at Iceville, near Atlanta. It was not expected that these fish could pass up farther than Columbus till fishways were placed at the obstructions at that place. True to their instincts, shad appeared in 1883 in the Chattahoochee River below Columbus, and were taken with the hook and bait. It is therefore reasonable to suppose that the fish thus taken were of the planting at Iceville in 1880. Of the 1,800,000 shad planted in 1881, 1,000,000 were released in the Ocmulgee at Macon. The fish, of course, were due on their return in the spring of the present year. I have recently visited Macon and made careful investigation in regard to the expected return of these fish, and I am pleased to say that I have not been disappointed. While there was no particular arrangement for catching shad—and hence the catch was light—still they must have appeared in large numbers, as a sporting gentleman informed me that full-grown shad were taken in considerable numbers, the fishermen standing on the bank of the stream and capturing them with the dip-net. I mention these facts to show with what facility a barren river can be impressed by liberal plantings of the shad fry."

p. **The River Herring** (*Pomolobus æstivalis*).

Large quantities of herring are often taken in the shad seines, and the opportunity has frequently been improved to impregnate the eggs and hatch them artificially.

q. **The Carp** (*Cyprinus carpio*).

The work connected with the carp may be considered among the most important of the operations of the Commission. The good results have been manifested over the entire country and the demand for the species is increasing year by year.

The number of carp raised in Washington, as reported by the superintendent of the ponds, Mr. Rud. Hessel, was as follows:

Place.	Scale carp.	Leather carp.	Blue carp.
North pond		24,449	
South pond		9,995	
East pond		80,456	
West pond		*50,000	
Arsenal pond	30,000		
No. 5 pond			14,379
No. 6 pond			2,400
Sand wharf pond			4,000
Total	30,000	164,900	20,779

*Estimated. In addition to this number, 57,000 were raised but were killed by frost in March, 1885.

Distribution of carp from October 28, 1884, to March 10, 1885.

State.	Point of distribution.	Number of counties included.	Number of applicants supplied.	No. of fish issued. To individual applicants.	No. of fish issued. To State commissioners.	Total number of fish issued.
Alabama	Montgomery and Birmingham, Ala.	39	180	3,640	....	3,640
Arizona	Ash Fork, Ariz	6	65	1,270	700	1,970
Arkansas	Saint Louis, Mo., and Marshall, Tex.	19	140	2,801	....	2,801
California	Ogden, Utah	16	19	380	....	380
Colorado	Denver, Colo	15	34	680	....	680
Connecticut	Boston, Mass	6	30	606	....	606
Dakota	Saint Paul, Minn	20	36	720	....	720
Delaware	Washington, D. C	3	13	210	100	310
Dist. of Columbia.	do	....	13	260	....	260
Florida	Jacksonville, Fla	13	35	700	....	700
Georgia	Atlanta and Albany, Ga	111	820	17,109	*1,700	18,809
Illinois	Chicago, Ill	84	425	7,194	12,000	19,194
Indiana	Indianapolis, Ind	71	250	5,088	....	5,088
Indian Territory	Dallas, Tex	3	4	180	†1,800	1,980
Iowa	Des Moines, Iowa	58	155	2,976	3,000	5,976
Kansas	Topeka, Kans	67	282	5,833	....	5,833
Kentucky	Louisville, Ky	21	41	827	350	1,177
Louisiana	Shreveport and New Orleans, La.	22	51	1,131	2,700	3,831
Maine	Boston, Mass	2	2	40	....	40
Maryland	Washington, D. C	13	58	895	1,960	2,855
Massachusetts	Boston, Mass	10	16	320	....	320
Michigan	Northville, Mich	32	63	1,282	....	1,282
Minnesota	Saint Paul, Minn	19	33	750	4,500	5,250
Mississippi	Jackson, Miss	46	226	4,568	....	4,568
Missouri	Saint Louis, Mo	16	23	490	....	490
Montana	Garrison, Mont	6	10	410	....	410
Nebraska	Omaha, Nebr	28	63	1,324	940	2,264
Nevada	Ogden, Utah	1	3	60	....	60
New Hampshire	Boston, Mass	4	8	180	....	180
New Jersey	New York, N. Y	17	74	1,432	....	1,432
New Mexico	Albuquerque, N. Mex	10	33	880	....	880
New York	New York, N. Y	39	109	2,290	2,000	4,290
North Carolina	Charlotte, N. C	63	771	15,110	....	15,110
Ohio	Columbus, Ohio	73	398	8,005	2,900	10,905
Oregon	Portland, Oreg	19	69	1,555	....	1,555
Pennsylvania	Washington, D. C	57	438	7,224	5,800	13,024
Rhode Island	Boston, Mass	1	1	30	....	30
South Carolina	Charlotte, N. C	28	165	3,355	1,700	5,055
Tennessee	Nashville and Chattanooga, Tenn.	45	201	4,075	....	4,075
Texas	Dallas, Austin, El Paso, and Marshall, Tex.	56	182	3,710	....	3,710
Utah	Salt Lake City and Milford, Utah.	16	159	3,180	....	3,180
Vermont	Boston, Mass	5	9	190	400	590
Virginia	Washington, D. C	72	453	7,074	....	7,074
Washington	Portland, Oreg., and Walla Walla, Wash.	15	61	1,569	....	1,569
West Virginia	Washington, D. C	27	90	1,421	500	1,921
Wisconsin	Saint Paul, Minn	20	31	624	....	624
Wyoming	Laramie City, Wyo	1	1	20	980	1,000
Mexico	....	....	4	125	....	125
Canada	....	....	5	100	....	100
England	....	....	1	25	....	25
Total	....	1,315	6,313	123,918	44,030	167,948

* Planted in Tallapoosa River December 13, 1884.
† Planted in Arkansas and Red Rivers January 4, 1885.

The distribution to Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia was made October 28; to a part of Arkansas, to California, Colorado, Connecticut, Dakota, Georgia, Illinois, Indiana, Iowa, Kansas, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Hampshire, New Jersey, New York, North Carolina, Ohio, Rhode Island, South Carolina, Tennessee, Vermont, Wis-

consin, and Wyoming, in November; to Alabama, Florida, Kentucky, Nebraska, Nevada, Oregon, Utah, and Washington, in December; to Arizona, a part of Arkansas, to Indian Territory, a part of Louisiana, to New Mexico, and Texas, in January; to Mississippi, February 12, 1885, and to part of Louisiana, March 10, 1885.

Distribution to public waters of scale carp reared in 1884.

Date.	Stream.	Place.	Number.
Dec. 13, 1884	Tallapoosa River	Tallapoosa, Ga	1,700
Jan. 4, 1885	Arkansas River	Muscogee, Ind. T	900
Jan. 4, 1885	Red River	Denison City, Tex	900
	Total		3,500

r. **The Goldfish** (*Carassius auratus*).

Goldfish were raised as usual at the carp ponds under the direction of Mr. Hessel, as follows: In pond No. 1, 3,900; in pond No. 2, 843; in 3 subdivisions of north pond, 7,900; total, 12,643. During this year fish were distributed to 524 applicants.

s. **The Golden Ide or Orf** (*Leuciscus idus*).

This ornamental fish, which occurs in great variety and is very attractive, is cultivated by the Commission for distribution, many persons preferring them to goldfish. There were 700 raised this year at the Washington carp ponds.

t. **The Tench** (*Tinca vulgaris*).

A small number of tench are cultivated in the Washington ponds, but there is little demand for them. There were 6,000 young produced this season.

u. **The Catfish** (*Amiurus nebulosus*).

In previous reports reference has been made to the successful introduction of the catfish (*Amiurus nebulosus*) into various waters, their multiplication, and the very high esteem in which the fish has been held as an article of food. In June, one hundred catfish from the Potomac River were sent to State Commissioner Gosper, of Prescott, Ariz., to be deposited in the Colorado River.

v. **The Clam** (*Mya arenaria*).

The Saint Jerome Station.—Interesting results as to the growth of the common clam or mananose (*Mya arenaria*) were obtained at St. Jerome after the completion of the ponds. As the ponds were excavated upon ground not before submerged, it was found that the young fry of the clam which had gained access to the ponds after the spawning season of the oysters was over had made a surprisingly rapid growth in the sandy bottoms of the ponds. In seven months it was found that the young clams would grow to a considerable size, their shells having made a growth of from 1 to 1½ inches in length in that period of time.

w. **The Oyster** (*Ostrea virginica*).

The Saint Jerome Station.—As it had been determined to continue the experiments in oyster culture at this station, which had been acquired from the Maryland Fish Commission in 1882, Mr. William deC. Ravenel was appointed superintendent, and ordered to the station, but owing to the ice blockade in the Potomac River, he did not reach his post until the middle of February, and early in March he was able to commence the work of the preparation of ponds.

During the spring five ponds were constructed and provided with flumes for controlling the inlet and discharge of water on the rise and fall of the tide. These ponds were from 50 to 60 feet square, and were located near the dwelling-house; they were formed by the excavation of the marsh land adjacent to the cut or canal which had been dredged by the engineer department. Their average depth was 3 feet at high water.

During the spawning season of the oyster, Prof. John A. Ryder was sent to the station to conduct personally the experiments. From the 25th of June, spawn was procured regularly from the oysters taken from the adjacent ponds and the bay, and after the young oysters were hatched they were placed in the ponds, which had been provided with collectors formed of tiles, slate, shingles covered with mortar, fagots, wheat straw, shells, &c. Floating apparatus was also used, consisting of troughs, or boxes with permeable ends of cloth, to admit of a change of the water by the action of the tidal currents. Artificially fertilized ova were placed in these boxes with very slight evidence of success.

Into the ponds great quantities of fertilized spawn were introduced from the early part of July until in September, when it became evident that the breeding season was about at an end. Some spat was obtained as a result of this method. But some of the ponds showed better results than others, the evidence being in favor of those through which there was the freest circulation of water. The results gave us a very complete confirmation of the results obtained in 1883, at Stockton, Md., and gave promise of further success the next season. That is, it was again shown that spat could be reared in artificially constructed inclosures.

At Wood's Holl two ponds were constructed in the fall of 1884, provided with very large filters at either end of the ponds. It was believed that the free access and circulation thus guaranteed would greatly favor our success. The subsequent trial of these ponds showed that the free circulation of the water thus established was a very desirable feature, as it seemed that the growth of the adult oysters in these ponds was greatly favored. Very rapid growth was made by the old oysters in these inclosures; in fact one-half inch of new shell was added to the margin of the valves of the old oysters in from six to eight weeks. It was also shown in the course of these experiments that oysters might be successfully grown at Wood's Holl, a locality in which that mollusk had never, so far as we know, been indigenous.

The improvements made by the engineer department at Saint Jerome during 1883 and 1884 caused the inclosure of a spacious pond, covering perhaps 10 or more acres, which may become a useful adjunct to future experiments. These improvements also render it possible greatly to extend the construction of other ponds or inclosed areas for purposes of oyster culture, though the excavation of the sandy flats for such purposes may be a trifle more expensive than upon the firm, loamy marshes found in many other places along the shores of the Chesapeake and Chincoteague Bays.

x. **The American Lobster** (*Homarus americanus*).

October 18, Lieut. W. M. Wood procured from Mr. E. G. Blackford, in New York, 125 live lobsters of small and medium size, many of them being females with a full supply of eggs. They were placed in a tank through which salt water was circulated, but quite a number died the first few hours. On arrival in the Chesapeake, the next day, he deposited 63 in good condition off Back River light.

D.—ABSTRACT OF THE ARTICLES IN THE APPENDIX.

25.—CLASSIFICATION OF ARTICLES.

In the general appendix to this report will be found a series of forty-two separate papers treating upon matters relating to the work of the Fish Commission. These are classified under five headings, as follows:

A.—Reports of Steamers and Stations

The first article is by Lieut.-Commander Z. L. Tanner, and gives a report of the work of the steamer Albatross during 1884, illustrated by three plates. In this report are also included subordinate reports by Lieut. Seaton Schroeder, Passed Assistant Engineer G. W. Baird, Surgeon James M. Flint, Naturalist James E. Benedict, and various tables of temperatures, specific gravities, stations occupied, records of dredging and trawling, and lists of fishes, invertebrates, &c., taken. Next is given a report by Lieut. W. M. Wood on the work of the Fish Hawk during 1883 and 1884; and a report follows by Mate James A. Smith on the work of the Lookout during 1884. The twelve papers which follow relate mostly to the propagating operations of the Fish Commission, and consist of reports from the persons charged with the work of propagation, distribution, or investigation. They consist of three reports on fish hatching, shipping eggs to foreign countries, and receiving them from foreign countries at the Cold Spring Harbor Station, by Mr. Mather; the operations at the Northville and the Alpena Station, by Mr. F. N. Clark; the salmon-breeding and trout-breeding work on the McCloud River, by Mr. Stone; the work in Maine in propagating Penobscot salmon and Schoodic salmon, by Mr. Atkins; the shad-hatching operations at the Fort Washington Station, by

Lieutenant Babcock; the shad work at the Havre de Grace Station, by Mr. Hamlen; the work with oysters at the Saint Jerome Station, by Mr. Ravenel; and a report on the water supply of the station at Wood's Holl, by Dr. Kidder.

B.—The Fisheries.

The fifteen papers in this section are of a somewhat general or statistical nature, giving a view of the fisheries of this country and of northern Europe. The first article is a report by Colonel McDonald on the protection which should be afforded by law to the fisheries of the Atlantic coast. A paper follows on the New England fishery for swordfish during 1884, by Mr. A. Howard Clark. Next comes an article giving the statistics of the United States imports and exports of fish and fishery products, the tonnage of fishing vessels, &c., for the fiscal year ending June 30, 1884, compiled by Mr. Smiley from information furnished by the Bureau of Statistics. Captain Collins has an article on the use of gill-nets in the cod fisheries, with a description of the Norwegian cod-nets and a history of their use in the United States, illustrated by twelve plates; and another paper giving an account of the trips of three Gloucester schooners to the Iceland halibut fishing-grounds. The fisheries of Iceland are treated of in four papers, each being a translation from the Danish. The statistics of the Norwegian fisheries in 1880 are given by Boye Strom, after which comes a translation from the Danish on the need of a central management for the Norwegian fisheries. A valuable paper is given by Dr. Rudolph Lundberg on the fisheries of Sweden, illustrated by a plate showing some of the kinds of apparatus used. This is followed by an article from the Swedish by Prof. A. V. Ljungman on the future of the herring fisheries on the coast of Bohus; and an other from the Danish by Lieut. Carl Trolle on salting fish in Jutland. The last paper of the section is a translation from the Danish on the salting of herring, giving valuable information and suggestions in regard to this work.

C.—Fish-Culture.

The first of the five papers in this section is a review of the failures and successes of artificial fish-culture, by Von der Wengen. This is followed by a long article, by Carl Nicklas, on pond culture, being specially applied to the methods of carp culture in Germany, illustrated by forty-four figures and provided with a table of contents and special index. Next is an article by Chas. W. Smiley on some results of carp culture in the United States, which consists mostly of statements of persons thus engaged. An article by Dr. Horst, translated from the Danish, on the development of the European oyster, is illustrated by two plates; and is followed by a statement, translated from the Danish, on oyster culture as seen at the London Fisheries Exhibition, by S. A. Buch.

D.—SCIENTIFIC INVESTIGATION.

Of the five papers in this section, the first is a report by J. Walter Fewkes, on the medusæ collected by the Albatross in the Gulf Stream region in 1883–'84, illustrated by ten plates. The next is an article on the origin of heterocercy and the evolution of the fins and fin-rays of fishes, illustrated by eleven plates and eight figures, by John A. Ryder. Messrs. Chittenden and Cummins furnish a paper on the relative digestibility of fish flesh in gastric juice, with tables of their experiments. Two translations from the German follow, the first on the migrations of eels, by Dr. Hermes; and the other being a contribution to the natural history of parasites as affecting certain kinds of fish, by Dr. Kerbert.

E.—MISCELLANEOUS.

In this section is a statement of the status of the U. S. Fish Commission in 1884, by G. Brown Goode; while the appendix is concluded by a paper from the German on the results of the London Fisheries Exhibition in their practical value for Germany, by Dr. Benecke, being a general review of the subject and of the articles exhibited.

This series of forty-two papers contains many of high value, and is illustrated by nearly one hundred plates and figures. Nine of the longest articles are provided with special indexes, as it is often desirable to issue these papers in separate pamphlet form for distribution to specialists not interested in the contents of the entire volume.

E.—SUPPLEMENT TO THE REPORT PROPER.

26.—LIST OF LIGHT-HOUSE KEEPERS RENDERING ASSISTANCE.

The following is a list of the light-houses (with their keepers) at which temperatures and occurrences of ocean fish have been observed during a portion or all of the present year:

List of light-houses on the Atlantic coast at which ocean temperatures have been taken during the year 1884, *together with the number of monthly reports made at each one.*

Petit Manan light-house, Petit Manan Island.	
George L. Upton, Millbridge, Me	12
Mount Desert light-house, Mount Desert Rock.	
Thomas Milan, Southwest Harbor, Me	12
Matinicus Rock light-house, Penobscot Bay.	
William G. Grant, Matinicus, Me	12
Seguin light-house, Seguin Island, Kennebec River.	
Thomas Day, Hunnewell's Point, Me	12
Boon Island light-house, Boon Island, Me.	
Alfred J. Leavitt, box 808, Portsmouth, N. H	12
Minot's Ledge light-house, Cohasset Rocks, Boston Bay.	
Frank F. Martin, Cohasset, Mass	12
Race Point light-house, Cape Cod Bay.	
James Cashman, Provincetown, Mass	12

Pollock Rip light-station, entrance to Vineyard Sound.
Joseph Allen, jr., South Yarmouth, Mass 12
Nantucket New South Shoal light-station, Davis New South Shoal.
Andrew J. Sandsbury, Nantucket, Mass. (Isaac Hamblen, Nantucket, Mass., reported August and September) 12
Cross Rip light-station, Vineyard Sound.
Luther Eldridge, Chatham, Mass 12
Buoy Depot, Government wharf, office of Light-House Inspector.
Benjamin J. Edwards, Wood's Holl, Mass 12
Vineyard Sound light-station, Sow and Pigs Rocks.
William H. Doane, 13 Kempton street, New Bedford, Mass. (A. H. Bray reported for month of January) 12
Brenton's Reef light-station, off Brenton's Reef and Newport Harbor.
Charles D. Marsh, 54 John street, Newport, R. I 12
Block Island light-house, southeast end of Block Island.
H. W. Clark, Block Island, R. I 12
Bartlett's Reef light-station, Long Island Sound.
Daniel G. Tinker, New London, Conn 12
Stratford Shoals light-house, Middle Ground, Long Island Sound.
James G. Scott, Miller's Place, Suffolk County, New York 12
Fire Island light-house, south side of Long Island.
Seth R. Hubbard, Bay Shore, N. Y 12
Sandy Hook light-house, entrance to New York Bay.
R. H. Pritchard, 120 Spencer street, Brooklyn, E. D., N. Y 12
Absecom light-house, Absecom Inlet.
A. G. Wolf, Atlantic City, N. J 12
Five-Fathom Bank light-station, off Delaware Bay.
William W. Smith, Cape May, N. J 12
Fourteen-Foot Bank light-station, Delaware Bay.
Ed. A. Howell, Delaware City, Del.; and John Lund, Wilmington, Del 12
Winter-Quarter Shoal light-station, Chincoteague Island.
C. Lindemann, 857 Broadway, Brooklyn, E. D., N. Y 12
York Spit light-house, Chesapeake Bay.
James K. Hudgins, Port Haywood, Va 12
Wolf-Trap Bar light-house, Chesapeake Bay, Va.
John L. Burroughs, New Point, Matthews County, Va 12
Stingray Point light-house, Chesapeake Bay.
Charles F. Sadler, Hudgins, Va 12
Windmill Point light-house, mouth of Rappahannock River.
James G. Williams, Hudgins, Va 12
Point Lookout light-house, mouth of Potomac River.
William Yeatman, Cornfield, St. Mary's County, Md. (Record began December 1, 1884) 1
Body's Island light-house, north of Cape Hatteras.
Peter G. Gallop, Manteo, Dare County, N. C 12
Cape Lookout light-house, Cape Lookout.
Denard Rumley, Beaufort, N. C 12
Frying-Pan Shoal light-station, Cape Fear.
John D. Davis, Smithville, N. C.; George D. Walker, Smithville, N. C.; and Henry Swan, Smithville, N. C 12
Rattlesnake Shoal light-station, off Charleston.
John McCormick, Charleston, S. C 12
Martin's Industry light-station, off Port Royal.
John Masson, Beaufort, S. C 12

Fowey Rocks light-house, Fowey Rocks.	
John J. Larner, Miami, Fla	12
Carysfort Reef light-house, Florida Reefs.	
F. A. Brost, Key West, Fla	12
Dry Tortugas light-house, Loggerhead Key.	
Robert H. Thompson, Key West, Fla	12

27.—LIST OF RAILROADS FURNISHING TRANSPORTATION AT REDUCED RATES.

It has already been mentioned that the railroads of the country in general have transported the cars of the Commission at a rate of 20 cents per mile, this including the fare of five messengers—a figure very much less than the usual charge for such service, and showing the favorable consideration entertained by the companies toward the work of the Commission. In some cases 10 cents per mile has been charged; in other cases 5; and again, for many thousands of miles the service has been conducted without any cost whatever to the Commission. The only road that charged any more than 20 cents is the Union Pacific, on the trip to Ogden, Utah, and return, during the latter part of November.

List of railroads that moved cars, and messengers to the number of five accompanying, at the rate of 20 cents a mile during the year 1884.

	Miles.
Alabama Great Southern Railway; Chattanooga, Tenn	143
Baltimore and Ohio Railroad; Baltimore, Md	546
Central Railroad of Georgia; Savannah, Ga	239
Charlotte, Columbia and Augusta Railroad; Columbia, S. C	191
Chicago, Burlington and Quincy Railroad; Chicago, Ill	503
Chicago, Milwaukee and Saint Paul Railway; Milwaukee, Wis	580
Chicago and Northwestern Railway; Chicago, Ill	467
Cumberland Valley Railroad; Chambersburg, Pa	74
Delaware and Hudson Canal Company; New York, N. Y	123
Delaware, Lackawanna and Western Railroad; New York, N. Y	497
East Tennessee, Virginia and Georgia Railroad; Knoxville, Tenn	1,758
Georgia Pacific Railway; Birmingham, Ala	167
Housatonic Railroad; Bridgeport, Conn	70
Louisville and Nashville Railroad; Louisville, Ky	338
New York, New Haven and Hartford Railroad; New York, N. Y	102
New York, West Shore and Buffalo Railroad; New York, N. Y	282
Norfolk and Western Railroad; Philadelphia, Pa	967
Pennsylvania Railroad; Philadelphia, Pa	7,201
Pennsylvania Company; Pittsburg, Pa	2,039
Pittsburg, Cincinnati and Saint Louis Railway; Pittsburg, Pa	3,048
Richmond and Danville Railway; Richmond, Va	957
Richmond, Fredericksburg and Potomac Railroad; Richmond, Va	82
Savannah, Florida and Western Railroad; Savannah, Ga	258
Shenandoah Valley Railroad; Philadelphia, Pa	239
Terre Haute and Indianapolis Railroad; Terre Haute, Ind	1,680
Virginia Midland Railway; Alexandria, Va	1,702
Western and Atlantic Railroad; Atlanta, Ga	140
Total	24,393

Concessions of free transportation for cars and messengers, and every facility for the convenience and expedition of the work of distribution, have been afforded by 26 roads. The aggregate number of miles of free transportation received was 21,865.

List of railroads that moved cars, and messengers to the number of five accompaning, free of charge during the year 1884.

Atchison, Topeka and Santa Fé Railroad Company; Topeka, Kans.
Atlantic and Pacific Railroad; Albuquerque, N. Mex.
Chicago and Grand Trunk Railway; Chicago, Ill.
Chicago, Milwaukee and Saint Paul Railway; Milwaukee, Wis.
Chicago and Northwestern Railway; Chicago, Ill.
Detroit, Grand Haven and Milwaukee Railway; Detroit, Mich.
Detroit, Lansing and Northern Railroad; Detroit, Mich.
Flint and Pere Marquette Railroad; East Saginaw, Mich.
Grand Rapids and Indiana Railroad; Grand Rapids, Mich.
Grand Trunk Railway; Montreal, Canada.
Great Western Railway of Canada; Toronto, Canada.
International and Great Northern Railroad.
Lake Shore and Michigan Southern Railway; Cleveland, Ohio.
Michigan Central Railroad; Detroit, Mich.
Milwaukee, Lake Shore and Western Railway; Milwaukee, Wis.
Missouri Pacific Railway; Saint Louis, Mo.
Northern Pacific Railroad; Saint Paul, Minn.
Oregon Railway and Navigation Company; Portland, Oreg.
Richmond and Alleghany Railroad; Richmond, Va.
Rome, Watertown and Ogdensburg Railroad; Oswego, N. Y.
Saint Louis, Iron Mountain and Southern Railway; Saint Louis, Mo.
Spartanburg and Ashville Railroad; Spartanburg, S. C.
Texas and Pacific Railway; Dallas, Tex.
Utah Central Railway; Salt Lake City, Utah.
Wabash, Saint Louis and Pacific Railway; Saint Louis, Mo.
Wisconsin Central Railroad; Milwaukee, Wis.

The Union Pacific Railway moved a car from Kansas City, Mo., to Ogden, Utah, and from Ogden to Council Bluffs, Iowa, at a somewhat reduced rate, 2,328 miles.

APPENDIX A.

REPORTS OF STEAMERS AND STATIONS.

I.—REPORT ON THE WORK OF THE UNITED STATES FISH COMMISSION STEAMER ALBATROSS FOR THE YEAR ENDING DECEMBER 31, 1884.

By Lieut.-Commander Z. L. Tanner, U. S. N., Commanding.

The Albatross was on Skinner & Son's Marine Railway, Baltimore, Md., at the close of my last report ending December 31, 1883, for the purpose of cleaning and painting her bottom.

The weather on January 1, 1884, was unfavorable for our work, being rainy and misty, followed on the 2d by severe cold, which not only interfered with putting on the paint, but delayed its drying on the frosty surface of the iron. We succeeded, however, in getting on two coats, the first of red lead, followed by one of white zinc; and lowered her from the railway into the water on the evening of the 5th, although the last coat of paint was not thoroughly dry. The ice was forming rapidly in the bay and harbor, and we feared it would cause us serious delay if we remained longer on the dock. As it was, we found it between two and three inches thick when we left the harbor the following morning, and were obliged to force our way through it, scraping the fresh paint from the vessel's sides and bottom several feet below the water-line.

Arriving at Hampton Roads at 12.20 a. m. on the 7th, we anchored till daylight, then steamed up to the navy-yard, Norfolk, Va., and moored to the coal wharf at 8.40 a. m. We went to Norfolk to escape the ice, to fill up with coal, and to meet the naturalists, who joined us at that port. The coal was on board on the evening of the 9th, and the vessel ready for sea.

Our destination was the West Indies, where, under the direction of the Bureau of Navigation, Navy Department, we were to be employed in surveying, deep-sea sounding, &c. The Hydrographer and the Chief of the Bureau of Navigation considered it desirable to have the Caribbean Sea sounded, its currents and temperatures observed, besides other investigations in that region which could be made only by a steamer completely fitted for the work. The Navy had no available vessel at the time, and knowing that the Albatross was eminently qualified to perform the rather difficult task, the Chief of the Bureau requested her services for the winter.

The following correspondence will explain the arrangements finally made with the Bureau of Navigation, and also the instructions under which we were about to sail:

BUREAU OF NAVIGATION, NAVY DEPARTMENT,
Washington, D. C., November 27, 1883.

SIR: Referring to our conversation of a few days ago, I have the honor to ask whether it will be practicable to obtain the use of the U. S. F. C. steamer Albatross this winter, for the purpose of making surveys and examinations in the Caribbean Sea under the direction of this Bureau.

Very respectfully,

J. G. WALKER,
Chief of Bureau.

Prof. SPENCER F. BAIRD,
Secretary Smithsonian Institution, Washington, D. C.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., December 1, 1883.

SIR: In reply to your letter of November 27, I beg to say that it will give me much pleasure to authorize the use of the steamer Albatross for the performance of the service desired by the Navy Department—namely, of prosecuting soundings and surveys in the Caribbean Sea.

The steamer is now being placed in a thorough state of efficiency and equipment at the expense of the U. S. Fish Commission, and in the event of her entering on your work it is to be understood that all expenses of maintenance and repairs are to be borne by the Navy Department during her term of service; and that the vessel is to be returned to the Commission at the navy-yard in Washington or in New York by the 1st of May next, with clean bottom and in an equally perfect condition, and ready for service.

Captain Tanner will be duly instructed to carry out any plan of operations you may designate as being desired by the Department.

I have the honor to be, very respectfully, your obedient servant,

S. F. BAIRD,
Commissioner.

Commodore J. G. WALKER,
Chief of Bureau of Navigation, Navy Department.

BUREAU OF NAVIGATION, NAVY DEPARTMENT,
Washington, D. C., December 14, 1883.

SIR: I have the honor to acknowledge with thanks the receipt of your letter of the 1st instant, authorizing the use of the Fish Commission steamer Albatross in the prosecution of surveys in the Caribbean Sea, under the direction of the Bureau of Navigation, provided that all the expenses of maintenance and repairs are to be borne by the Navy Department during the term of her service, and the vessel to be returned to the Fish Commission at Washington or New York by May 1st next, with clean bottom and in a condition as good as that in which she was received.

In reply I have the honor to state that all expenses of maintenance and repair of the vessel during the term she is under the direction of the Bureau of Navigation will be borne by the Bureau, and the vessel will be returned to the Fish Commission, either at New York or Wash-

ington, by the 1st of May next, with clean bottom and in as good condition as she shall be when received, accidents and the wear and tear of time and legitimate service excepted.

Very respectfully,

J. G. WALKER,
Chief of Bureau.

Prof. S. F. BAIRD,
Commissioner.

BUREAU OF NAVIGATION, NAVY DEPARTMENT,
Washington, December 21, 1883.

SIR: In reply to your letter of the 15th instant, requesting a formal statement of the character of the service desired from Lieutenant-Commander Tanner in the Albatross, I beg leave to inclose the instructions which have been prepared in this Bureau for his guidance during the time that he shall be employed in obtaining the information desired by the Navy Department.

As it is understood that Lieutenant-Commander Tanner is to do certain work for the U. S. Fish Commission during his cruise in the Caribbean Sea, it is expected that in case he should be delayed by that work, the support of the steamer during such delay will be borne by the Fish Commission.

Very respectfully,

J. G. WALKER,
Chief of Bureau.

Prof. SPENCER F. BAIRD,
Commissioner, U. S. Fish Commission, Washington, D. C.

BUREAU OF NAVIGATION, NAVY DEPARTMENT,
Washington, December 20, 1883.

SIR: You will be guided by the following instructions during the time that you are employed in making the examinations desired by this Bureau.

Run a line of traverses from the island of St. Thomas, along the south side of the island of Porto Rico, from the vicinity of the shore to the 100-fathom curve. As the south part of the coast of this island is very imperfectly known, the traverses should extend to Aguila Point.

Run a line of deep-sea soundings from the west end of Santa Cruz to a point south of the east end of Porto Rico, in order to ascertain if these islands are connected, as the temperatures found by the United States Coast and Geodetic Survey steamer Blake in 1879, would seem to indicate.

From Aguila Point run a line of deep-sea soundings across the Caribbean Sea to the island of Blanquilla. The soundings are to be taken at such distances as the contour of the bottom may suggest, but not to be more than twenty-five miles apart.

From the island of Blanquilla run traverses from the 100-fathom curve to the shore, as far as Curaçao, making an examination of the localities on which the sea is reported to "break."

At Curaçao you can probably obtain coal.

From Curaçao run a line of deep-sea soundings to the island of Beata, and run traverses to the 100-fathom curve along the south side of the island of Santo Domingo, sounding carefully over the reported dangers south of Aux Cayes.

From Santiago de Cuba to Kingston, Jamaica, stop off Morant Point and develop the reported shoal off the point, marked 8 fathoms.

From Kingston run a line to Santa Marta, New Granada, taking in the doubtful shoal on the way.

Make an examination of the mouth of the Magdalena River, for which special instructions are sent you.

From Savanilla run traverses along the coast to Aspinwall.

From thence proceed to Cape San Antonio, west end of Cuba; take deep-sea soundings off Cape San Antonio, in order to determine definitely that the reported dangers do not exist, and determine the exact longitude of the light-house on Cape San Antonio, if possible.

Deep-sea soundings will be valuable whenever they are not already on the charts furnished you.

It is of great importance that the depths, temperatures, and currents of the main Caribbean should be investigated, and the suggestions for the lines of deep-sea soundings are for that purpose.

The necessary expenditures for coal and other supplies required while engaged in the duty strictly under this Bureau will be charged to the appropriation, "Special Ocean Surveys," Navigation, 1883–'84. As this appropriation is limited in amount, it is expected that you will use great care in economizing coal and other supplies.

It is understood that this Bureau is not to be charged with the expenses of the ship while you are engaged in work not under its cognizance.

Very respectfully,

J. G. WALKER,
Chief of Bureau.

Lieut.-Commander Z. L. TANNER, U. S. N.,
Commanding U. S. Fish Commission Steamer Albatross.

BUREAU OF NAVIGATION, NAVY DEPARTMENT,
Washington, December 26, 1883.

SIR: During the time you are engaged in surveying work in the Caribbean Sea, it is expected that you will make an examination of the entrance to the Magdalena River and of its channels as far as Barranquilla, United States of Colombia.

The inclosed copies of letters from the Secretary of State and the United States consul at Barranquilla show the necessity of the work.

Very respectfully,

J. G. WALKER,
Chief of Bureau.

Lieut.-Commander Z. L. TANNER, U. S. N.,
Commanding U. S. Fish Commission Steamer Albatross,
Washington, D. C.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., December 27, 1883.

SIR: I have forwarded to you the communications from the Navy Department, embodying the information which it desires to obtain, and on account of which it has been determined to send the Albatross to sea for a winter's cruise.

You will use your best endeavors to solve as many of the problems presented by the Department as practicable, within the limit of time allotted to your cruise.

You are instructed to return to Washington as early in May as possible, so as to be able to make a cruise in northern waters by the beginning of June. This, of course, is subject to such contingencies as may develop themselves hereafter.

In returning by way of Cape San Antonio it will be well to make a run into the Gulf of Mexico and spend a short time in making soundings and dredgings therein, for the purpose of obtaining a general idea of the natural history and the fisheries of the Gulf, preliminary to a more lengthened visit to be made hereafter.

In connection with the work of soundings you will take occasional hauls of the dredge and trawl, and preserve carefully such numbers of specimens as the naturalists may recommend.

In addition to the purely physical work asked for by the Navy Department, or constituting a part of the general plan of research of the steamer, you are instructed to do what is in your power towards obtaining a knowledge of the natural history of the shores and waters visited; giving such facilities to those connected with this department as may be in accordance with the best interests of the expedition.

It is considered particularly important to secure a fair representation of the shore fauna of the Caribbean Sea and its surroundings, as there is much to be learned in regard to areal distribution of the various species of animals and plants.

Where practicable, a small boat-dredge should be used from the launch, as likely to furnish many shallow-water species of interest to science.

An important branch of research consists in the investigation of the parasites of the larger fish, such as sharks, swordfish, &c. These should, as far as possible, be secured and carefully overhauled for this object. The jaws and teeth of the larger sharks should also be preserved after having been properly identified.

In the department of marine birds, there is a large field for research, there being many species of gulls, petrels, herons, cormorants, gannets, &c., of which but little is known.

Reptiles, freshwater fishes, and the various species of mammals should also be secured.

Attention is invited to the study of the cetaceans; and, if practicable, drawings and photographs should be taken and the crania properly preserved.

Whenever an opportunity presents itself of obtaining aboriginal relics, in the way of articles of stone, pottery, &c., care should be taken to secure them. Illustrations of the handiwork of the modern tribes of the coast, especially such as relate to their methods of hunting and fishing, should also be gathered.

Fossil remains of any kind, minerals, specimens of rock, &c., are very desirable.

I would advise that whenever a convenient opportunity occurs, the dried specimens, such as skins of birds and mammals, jaws of fish, &c., be transmitted to Washington, so as to relieve the store-rooms of the steamer. Such objects should be addressed to the "Smithsonian Institution, Washington, D. C.," and, as far as possible, sent by way of New York, in which case they should be marked "Care of Collector of Customs," who should be advised of the same.

A formal statement of the fact and mode of shipment should always accompany each sending.

Very respectfully,

SPENCER F. BAIRD,
Commissioner.

Captain TANNER,
U. S. Steamer Albatross, Baltimore, Md.

The following officers were attached to the ship and made the cruise in the West Indies:

Z. L. Tanner, lieutenant-commander, U. S. N., commanding.

Seaton Schroeder, lieutenant, U. S. N., executive officer and navigator.

S. H. May, lieutenant, U. S. N.

A. C. Baker, lieutenant, U. S. N.

C. J. Boush, ensign, U. S. N.

R. H. Miner, ensign (junior grade), U. S. N.

L. M. Garrett, ensign (junior grade), U. S. N.

A. A. Ackerman, ensign (junior grade), U. S. N.

C. G. Herndon, passed assistant surgeon, U. S. N.

C. D. Mansfield, paymaster, U. S. N.

George W. Baird, passed assistant engineer, U. S. N., in charge of machinery.

Petty officers.—S. M. McAvoy, John Hawkins, John Bergesen, Walter Blundell, machinists; Charles Wright, master-at-arms; George B. Till, equipment yeoman; N. B. Miller, apothecary; George A. Miller, paymaster's yeoman; Frank L. Stailey, engineer's yeoman.

The crew numbered 59 men.

Mr. James E. Benedict was attached to the vessel as resident naturalist, with the following-named gentlemen as assistants:

Willard Nye, jr.

Ensign R. H. Miner, U. S. N., in charge of department of fishes.

Ensign L. M. Garrett, U. S. N.

Ensign A. A. Ackerman, U. S. N., in charge of department of geology and mineralogy.

We left the navy-yard, Norfolk, Va., at 7 a. m., January 10, and proceeded to sea. The weather was clear and pleasant, with light westerly breeze in the morning, backing to SSW., and increasing to a strong wind during the latter part of the day.

Having passed Cape Henry, we laid a course for a reported danger marked "Orion," on the eastern verge of the Gulf Stream, off Hatteras. We entered the stream in latitude 35° 48′ 48″ N., longitude 74° 09′ 00″ W., the temperature of the water rising from 54° to 67°, finally reaching 71° F.

The following morning we had strong winds to moderate gale from SSW., with heavy confused swell, the sea becoming more regular later in the day. We were on the position of the shoal above-mentioned about noon, but did not consider it advisable to sound under the circumstances. A lookout was kept at the mast-head for anything that might indicate shoal water; but there was nothing seen, although the weather was clear and the sea heavy enough to mark a shoal anywhere within the line of vision.

Having passed the above position, a course was laid for another danger marked "Ashton," in latitude 33° 50′ 20″ N., longitude 71° 42′ 00″ W., and at 10.25 p. m. on the 11th we sounded in 2,953 fathoms,

the bottom being a light chocolate ooze, rich in foraminifera. The sounding was finished and we started ahead about midnight for still another danger marked "Perseveranza." It was our intention to sound at meridian on the 12th, but a southerly gale was blowing and the sea was so high that it was not considered advisable.

We had heavy rains during the day, and between 10 and 11 p. m. came a heavy shower with very large drops, a sure indication under the circumstances, both in the Atlantic and Pacific, of a shift of wind to the westward. The barometer ceases to fall and frequently begins to rise during such a shower, preceding the change of wind from a few minutes to an hour or more. At 11.10 p. m. the wind veered to WNW. with clearing weather, and later to NE. with a long heavy swell. The ship had been in the trough of the sea most of the time since leaving Hatteras, and, the wind backing to the southward, fore-and-aft sail only could be carried. The behavior of the vessel under the adverse circumstances was admirable, the heaviest lurch being 34° to port and 22° to starboard.

At 9.50 a. m. on the 13th we sounded in latitude 31° 15′ 22″ N., longitude 67° 39′ 10″ W., the position assigned to the "Perseveranza" shoal. We found 2,787 fathoms, and brought up light chocolate-colored ooze containing but few foraminifera. It is needless to say that shoal water was not the origin of this reported danger. There was a heavy swell, the spray frequently flying over the stern while we were sounding, but the vessel was held in position without difficulty and without unusual strain on the engines except occasionally when the propellers were thrown out of water. The lashings of the rudder chains were, however, soon carried away by the force of the sea.

We took the trade-winds during the night in latitude 29° 00′ 00″ N., from SE. to ESE., light to gentle breeze; the long, rolling swell from the NE. still continued. At 8.41 a. m. on the 14th we sounded in 2,957 fathoms, latitude 28° 17′ 07″ N., longitude 66° 17′ 37″ W.

At 11.48 a. m. on the 15th we sounded in 3,006 fathoms, yellow clay, latitude 24° 35′ 14″ N., longitude 65° 13′ 07″ W., on the position assigned to the danger marked "Mourand, 1773." There were already two soundings near the same spot, H. O. No. 21, one 3,560 fathoms and the other 2,850, but the danger still remaining on the chart led us to suppose that some doubt existed as to the accuracy of these soundings, and to settle the matter we concluded to take another, which proved conclusively that shoal water does not exist in that locality.

The trades continued light from SE., and the NE. swell having left us we had practically a smooth sea. Two soundings were taken on the morning of the 17th; the first in 3,468 fathoms, latitude 19° 15′ 00″ N., longitude 65° 07′ 00″ W., and the other in 1,902 fathoms, latitude 18° 59′ 00″ N., longitude 65° 07′ 00″ W. They were taken to define more fully the slope north of St. Thomas and to fill blanks in a line of soundings already plotted on H. O. No. 40. Having completed

the last sounding, we laid a course for St. Thomas, arriving at meridian. An officer was sent to call on the United States consul, V. V. Smith, esq., who returned to the ship with him. At 3 p. m., accompanied by the consul, I made an official visit to the governor, Oberst Arendrup, and during the call obtained permission for the scientists to shoot birds, &c., on the island. The governor expressed a desire to render us every assistance in his power.

Showers of rain were of frequent occurrence, this being the rainy season, which, it is said, lasts from about November until April. The rains and partially cloudy weather temper the atmosphere, and, was it not for the constant moisture, the climate at this season would be perfect.

Preparations were made for coaling, and on the 18th we took on board 92 tons of double-screened Cardiff coal, for which we paid $7.75 per ton stowed in the bunkers.

The scientists were thus far successful and anticipate excellent results from their labors here.

Mechanics commenced work in the boilers on the morning of the 19th and finished on the 23d. On the evening of the 22d, accompanied by five officers, I dined with the governor of St. Thomas, and on the following day he paid an official visit to the ship, carefully inspecting all her appointments, including the scientific apparatus. We received many courtesies from the government and people, and were greatly indebted to the United States consul for advice and assistance, not only in the ordinary business of the ship, but in making scientific collections. He even acted as pilot and guide to a lagoon in a remote part of the island, where many interesting specimens were procured.

We left St. Thomas at 7 a. m., January 24, and at 8.43 a. m. sounded in 516 fathoms 12′ SSW. of the light-house. The following lines were then run and soundings taken every 5′: SSW. (mag.) 50′; N. by W. ½ W. (mag.) 45′, and SW. ½ W. (mag.) 25′, developing a connecting ridge between Santa Cruz and Porto Rico having from 578 to 933 fathoms of water on it, 2,000 fathoms or more being found on either side. Serial temperatures were taken both east and west of the ridge.

Fresh winds were encountered after we left the islands, with frequent squalls of wind and rain and the short chopping sea peculiar to the Caribbean. At 10.10 p. m. on the 25th we started on a course SE. ¼ E. (mag.), sounding every 25′. The deepest water—2,690 fathoms—was found the first cast in latitude 17° 15′ 30″ N., longitude 65° 26′ 30″ W., the depth decreasing gradually to Aves Island, which we reached at 11.30 a. m. on the 27th. It was our intention to locate the island and give the naturalist an opportunity to examine it, but on approaching within a mile of the lee beach we found the surf much too heavy to admit of landing with safety.

The island is small and low, not over 10 feet in height, with a few low bushes, and near the center two rough board houses and a tall flagstaff

on which were hoisted the Venezuelan colors. Several men were seen about the buildings, but there were no boats visible, and they did not seem to expect us to attempt a landing. These men are left here during the winter to collect guano, which is shipped in the summer months when the trades are light and the sea smooth. Several huge piles of the fertilizer were seen near the beach ready for shipment.

The anchorage is on a white sand and coral spit running off from the SW. end of the island, and can be seen at a distance of two miles from a ship's deck, showing white water. The bottom can be seen distinctly in 15 fathoms 1½ miles from land. We found 355 fathoms 1′ west of the island, and after passing the anchorage laid a course S. by E. ½ E. (mag.), sounding every 5′. At 2.45 p. m. we put the trawl over in 683 fathoms, latitude 15° 24′ 40″ N., longitude 63° 31′ 30″ W. At 5 p. m. the trawl was landed on deck, after a very successful haul, containing numerous specimens of rare corals, fish, sponges, &c. The boat-dredge usually attached to the tail of the trawl came up full of the ooze of the sea-bottom, which proved to be particularly rich in foraminifera, principally globigerina.

After the trawl was up we resumed our course, sounding at intervals of 25′, getting from 684 to 871 fathoms, until at 9.16 a. m. on the 28th, after putting the trawl over in 690 fathoms, latitude 13° 32′ 40″ N., longitude 62° 54′ 00″ W., we hove it up and found it had not reached the bottom. A cast of the lead showed that we had deepened the water 125 fathoms.

Our soundings developed comparatively shoal water south of Aves Island, but did not determine whether we were traversing the crest of a ridge or a plateau. The sudden increase in depth on our easterly course demonstrated that we were near the eastern slope, and to determine its angle we ran 20′ SE. ¾ E. (mag.), sounding every 10′, the depth increasing from 815 fathoms at the point of departure to 1,028 fathoms at 10′ and to 1,686 at 20′. Soundings on the chart in 1,700 fathoms to the eastward of our position showed that we had reached the normal depth between the islands, so we changed the course to SW. ½ W. (mag.), sounding every 10′, intersecting our line from Aves Island 25′ to the southward of the point at which we left it, but the elevation had terminated. The soundings continued with remarkable regularity from 1,634 to 1,642 fathoms for nearly 40′, when we changed the course to SE. by S. (mag.), sounding every 25′ until the south end of Granada bore E. 35′ distant. Here the water began to shoal, and soundings were taken every 5′ up the slope, then every 10′ to the vicinity of Boca Grande, the entrance to the Gulf of Paria.

At 1.07 p. m., January 29, latitude 11° 48′ 30″ N., longitude 62° 17′ 30″ W., we sounded in 1,140 fathoms, and put the trawl over, veering to 1,800 fathoms on the dredge-rope. It dragged lightly for half an hour and then suddenly fouled, either by coming in contact with some obstruction or burying in the mud. The bridles came up with a por-

tion of the tail lashings, which were the last to part; but the trawl was lost.

At 6.30 a. m., January 30, we put the dredge over in 73 fathoms, latitude 11° 07′ 00″ N., longitude 62° 14′ 30″ W., and landed it on deck at 7.20, the frame being bent and the netting torn by coming in contact with coral patches. There were, however, several interesting specimens brought up.

We entered the Boca Grande at 2 p. m. and took two casts of the lead at points where negative soundings were shown on the chart, and at 5 p. m. anchored off Port of Spain. An officer was sent to the United States consul, J. Fowler, esq., immediately after our arrival, and, although quite late, he visited the ship the same evening, returning with the officer who called on him.

We hauled fires during the night to stop several leaks in the boilers.

During the rainy season, from about April to November, the trades are from east or south of east in Port of Spain, and from NE. during the dry season, which continues from November to April. The present season is exceptional, as the trades are still east and the rains continue.

At 11 a. m. on January 31 I called with the United States consul on the governor, Sir Sanford Freeling, and during the visit obtained a permit for Messrs. Benedict and Nye to use firearms in making scientific collections. The naturalists were at work in various directions, and on board ship we were busily employed rewinding the wire on one of the working reels and reeling a supply on the spare reels.

We made inquiries on shore about the caverns inhabited by the guacharo birds (*Steatornis caripensis*) in the vicinity of Mono Island. Several people had visited them in the summer time, but thought it would be impracticable to enter them at this season, as they were exposed to the full force of the sea, which was always more or less rough in winter. They all referred us to Mr. William Morrison, postmaster of Mono, as the person best able to give information or assistance. As it was desirable to procure specimens of this rare bird for the Smithsonian Institution, we left the ship at 7.30 the following morning in the steam-cutter, with the dinghy and skiff in tow, for Mono Island, about eleven miles from the anchorage. Messrs. Garrett and Ackerman were dropped off Gaspar Grande, in the skiff, to land and examine that island, Messrs. Benedict and Nye forming the party with me in the cutter.

We were fortunate in finding Mr. Morrison at home, and willing not only to give information, but to act as guide and assist us in every possible way. He first piloted us to a cave on the west side of Mono Island, inhabited by fishing-bats, where six of them were shot and placed in alcohol. We continued our course around the island to the Mono passage, procured the services of a native with his canoe, and then went to a cavern on Trinidad Island, about the center of the passage above-mentioned. This was inhabited by large numbers of the cave birds of which we were in search. Several attempts were made

to enter; in fact, two or three birds were shot, but it was impossible to recover them, as a heavy surf broke through the entire length of the cavern. As they could not be reached inside the cave, Messrs. Benedict and Nye remained to watch the entrance and attempt to shoot some as they came out at night, Mr. Morrison offering to furnish them with a boat and lodging. They succeeded in shooting a single specimen, which they brought on board the following morning. Mr. Nye was confident that, with their experience of the past night, they could do better if they had another chance.

We were employed during the day swinging ship under steam to obtain compass errors, and towards night we dropped Messrs. Benedict and Nye, with a party in charge of Lieutenant May, U. S. N., near the cave for a final attack on the birds. The ship, after finishing compass observations, anchored in Dehert Bay, Mono Island, for the night. The party returned from the cavern about 8 p. m. with one more bird, which was shot by Mr. Nye as it flew out. Others were killed, but could not be found in the darkness and the dense thicket.

There is a larger cave on the north side of Huevos, an island near by, inhabited by these birds, but the approach is impracticable during the winter months.

At 5.45 a. m., February 3, we got under way, steamed out of Dehert Bay into the Gulf of Paria and took three hauls of the trawl; the first two were successful, but during the third the trawl fouled on a coral patch and was lost, together with 300 fathoms of rope.

After entering the Caribbean we laid a course NW. (mag.), sounding every 10′ for 45′, then NW. by W. ¾ W. 125′, sounding every 25′. This course was taken in order to ascertain whether spurs run off to the northward from Los Testigos or Blanquilla. Having completed the line, we hauled up to NE. ½ N. (mag.), sounding every 25′, to determine the western slope of the ridge before mentioned, extending to the southward from Aves Island.

Our course was nearly head to wind and sea, which reduced the speed and increased our coal expenditure considerably, but we thought it advisable to ascertain the extent of the elevation referred to. We reached the summit in 652 fathoms, then kept away to NW. ½ W. (mag.), sounding as before, until we reached 2,000 fathoms, then every 50′ to latitude 16° 36′ 20″ N., longitude 66° 41′ 00″ W. in 2,501 fathoms. We then ran W. ¼ S. (mag.) 76′, and at 1.45 a. m., February 7, sounded in 2,458 fathoms, latitude 16° 35′ 20″ N., longitude 68° 00′ 30″ W. After the last sounding the course was changed to SSE. ½ E. (mag.), and soundings taken every 50′. A set of serial temperatures and water specimens were taken during the afternoon in latitude 15° 02′ 00″ N., longitude 67° 13′ 20″ W. Our soundings showed a gradual increase in depth as we went to the southward, and there is a probability that the greatest depth will be found in the southern portion of the Sea.

At 4.15 p. m., February 8, latitude 12° 54′ 40″ N., longitude 66° 11′

00″ W., we sounded in the position assigned to breakers reported in 1870 by H. D. M. S. Ancona, and found bottom at 2,768 fathoms. At 12.51 a. m. the following day we sounded in latitude 12° 10′ 30″ N., longitude 66° 11′ 00″ W., in the position assigned to a "vigia," reported in 1803, and found bottom at 2,707 fathoms. An intermediate sounding between the two reported dangers gave 2,814 fathoms. The positions of the above soundings were determined by astronomical observations during clear weather. A lookout was kept at the mast-head in daytime and an extra lookout at night, which, by the way, was bright moonlight, but there was no sign of shoal water discovered, and, whatever may be the origin of the breakers reported, they cannot be attributed to that cause. A possible solution may be found in the fact that strong currents prevail in this locality, and tide rips or even overfalls might be found under certain conditions.

The bottom has been generally yellow ooze, very rich in foraminifera, but the deep soundings of the 8th developed a yellow or brown clay almost wholly devoid of organic matter. After completing the soundings above-mentioned we started ahead, S. by W. (mag.), to pass between Orchilla and Los Roques. A sounding was taken at 3.30 a. m. and another at 6.20 a. m., latitude 11° 49′ 00″ N., longitude 66° 16′ 50″ W., the west end of Orchilla Island bearing east 6′. The above is an astronomical position, and shows both Orchilla and Los Roques to be placed about 4′ too far west on H. O. chart No. 40.

From the last position we ran S. by W. ¾ W. (mag.), sounding every 15′, until reaching the mainland about 10′ to the eastward of La Guayra, then NW. by W. ¼ W. (mag.) for Curaçao, sounding as before. The water shoaled gradually from 774 fathoms 6′ west of Orchilla, to 135 fathoms within 5′ of the mainland, increasing to 1,040 fathoms 56′ NW. (mag.) from La Guayra, and shoaling again as we approached Curaçao. The latter port and islands to the eastward are also about 4′ too far west on H. O. chart No. 40. The soundings were continued to a point 600 yards south of the entrance, where 74 fathoms was found. While in the act of sounding we were boarded by the harbor-master, who acted as pilot, and at 3.05 p. m., February 10, we anchored in the Schottegat, in 10½ fathoms, near the U. S. S. Vandalia. Boarding officers visited the ship from the Vandalia and the Alkmaar, a Dutch station-ship, with offers of assistance and tendering the usual civilities of the port.

The trade-winds were brisk to fresh in the vicinity of St. Thomas, with heavy swell, both wind and sea moderating as we went to the southward. Moderate to gentle winds were experienced after leaving Aves Island. Rain squalls were of frequent occurrence from St. Thomas to Trinidad and for two days after our arrival in that port. After that, for a while we had but few light showers.

The currents of the Caribbean north of latitude 13° N. we found thus far to trend to the southward of west about 1′ per hour, somewhat stronger near St. Thomas and Porto Rico, and weaker towards the

center of the Sea. To the southward of latitude 13° N. they trend to the northward of west, and between Trinidad and Blanquilla northwest from $1\frac{1}{2}'$ to $3'$ per hour. Between La Guayra and Curaçao it was about W. by S. to W. $\frac{1}{2}'$ per hour.

There were neither birds nor fish observed between St. Thomas and Aves Island, but from the latter point to Trinidad small flying-fish and flocks of sea-birds were seen daily. Flying-fish were also seen in the central part of the Sea, but no birds till we approached the islands, where we frequently observed them in great numbers in search of food. Two dolphins and two sharks represent the larger marine life seen thus far in the Caribbean.

During the 11th I paid official visits to his excellency N. Van den Brandhof, governor of Curaçao, Capt. Rush R. Wallace, U. S. S. Vandalia, and Capt. A. Baron Collot d'Escury, commanding the Dutch sloop of war Alkmaar. Captain Wallace visited the ship during the afternoon.

The naturalists were out collecting both on shore and in the lagoons. During my call on the governor I obtained permission for them to use firearms and shoot specimens for scientific purposes.

Preparations were made for coaling, and at 6.20 a. m. the following day we got under way and went alongside the brig Florence, of Sunderland, and commenced work at 8 a. m., taking 84 tons on board during the day. Coal is handled here in small wooden tubs, holding an average of 40 pounds, making it slow work. We finished at 11.30 a. m. on the 13th, having taken on board $119\frac{1576}{2240}$ tons of double-screened Cardiff coal, for which we paid $10 per ton, American gold, delivered in the bunkers. We returned to the anchorage between noon and 1 p. m., hauled fires, and blew down the port boiler for repairs.

Capt. A. Baron Collot d'Escury made an official visit to the ship. The American steamer Caracas left with mails for the United States, and the record of soundings to date and other reports were forwarded by her.

At 10 o'clock on the morning of the 14th the governor of Curaçao and party visited the ship and made a thorough inspection of the vessel and her apparatus. Dr. Herndon, Mr. Benedict, and I lunched with the governor on the 17th. The repairs on the boiler and engine were completed on the above date and preparations made for sea.

The temperature ranged from 71° to 82° during our stay, and at our anchorage, where the trade-winds had a clear sweep, the weather was very comfortable. We usually had several passing showers during the day, which tended also to temper the atmosphere. We were entirely free from mosquitoes and flies, which is quite unusual in the tropics. The naturalists were successful, both ashore and afloat.

We left Curaçao at 7.20 a. m. on February 18, and ran a line of soundings in a southerly direction to the mainland, the greatest depth being 738 fathoms. The government and people of Curaçao will watch

with peculiar interest the results of this line of soundings, as it will go far towards solving the problem of a much-needed supply of fresh water. The relation this island bears to the mainland has been heretofore unknown, the general impression being that it was an isolated volcanic peak, having no connection with the watershed of the contiguous coast of Venezuela. In this case water would not be found by sinking artesian wells. On the other hand, if connected with the mainland by a plateau or neck of land having a moderate depth of water over it, wells might be sunk with a fair probability of success. An effort was made recently by the colonial government to ascertain the depth of the channel, but without success. The vessel sent on that duty, being supplied only with the ordinary deep sea lead and line, failed to reach bottom. When the governor learned that we intended running this line of soundings he requested me to furnish him with a list of the depths found, which I have done, forwarding it from Kingston, Jamaica.

During the afternoon we made a haul of the dredge in 122 fathoms, and of the trawl in 208 fathoms, in the channel above-mentioned, with but moderate success. A few specimens were, however, secured from both hauls. The small amount of life on the bottom of the Caribbean compared with that off the New England coast has been a constant surprise to us during the cruise. We extended the line of soundings across the channel to a point five miles from the coast; then stood to the northward and westward, sounding at short intervals, until at 11.30 p. m. we made the light on the east end of Oruba, recently erected by the phosphate company that is working the rich deposits on that island. The greatest depth found on this line was 455 fathoms.

At 1 a. m. the following day a course was laid NNW. (mag.) for Alta Vela, a small island on the south coast of Santo Domingo. Soundings were taken at intervals of 10′, 20′, and 25′; and at 9.10 a. m. we sounded in latitude 13° 17′ 45″ N., longitude 70° 01′ 00″, W., with a depth of 1,701 fathoms, the bottom being composed of foraminiferous ooze and coarse coral sand. .The wind and sea being moderate, and indications favorable, we put the small beam-trawl over, veering to 2,800 fathoms on the dredge rope. It was landed on deck again at 2.25 p. m. with a few sponges, shrimp, small fish, &c., indicating anything but rich ground. Soundings were continued at varying intervals, the wind and sea gradually increasing until the morning of the 21st, when we passed a few miles to the westward of Alta Vela and laid a course NW. ½ W. (mag.) for Cape Jacmel, sounding at intervals of about 16′.

The deepest water found between Curaçao and Santo Domingo was 2,694 fathoms, in latitude 13° 40′ 20″ N., longitude 70° 10′ 45″ W. The bottom was brown ooze without a trace of foraminifera. The average depth was about 2,300 fathoms until within a short distance of the land, when it shoaled rapidly to 302 fathoms four miles SW. ¼ W. of Alta Vela; the next sounding, 16′ distant NW. by W. ¼ W., revealing 2,434 fath-

oms, the greatest depth between Curaçao and this place, with the single exception before mentioned.

The line was extended to Jacmel, showing bold water to the cape; then 60′ south crossing a ridge which extends westward from Alta Vela. We then ran a line NW. ½ N. (mag.) 40′, crossing the line of the ridge above-mentioned, but found it had terminated or changed its direction, as we carried a uniform depth of about 2,400 fathoms.

We then steamed 18′ WSW. (mag.) and sounded in 2,490 fathoms, brown ooze, latitude 17° 39′ 30″ N., longitude 73° 22′ 15″ W., "Leighton Rock awash," H. O. chart No. 36, being located in latitude 17° 37′ 00″ N., longitude 73° 21′ 00″ W. After another run of 15′ NW. by W. ½ W. (mag.) we sounded in 2,369 fathoms, brown ooze, latitude 17° 48′ 00″ N., longitude 73° 34′ 15″ W., "Loos Shoal" being placed in latitude 17° 45′ 00″ N., longitude 73° 30′ 00″ W., H. O. chart No. 36. These shoals were searched for in 1872 by H. M. S. Philomel and Plover, and, being unable to find them, they were expunged from the Admiralty charts, but as they were still shown on H. O. charts, we considered it advisable to settle the matter beyond all dispute by ascertaining the actual depth in the localities assigned them.

The soundings south and west of Jacmel were taken during the prevalence of strong winds and heavy confused seas. An easterly current of ¾ to 1 knot per hour was encountered in this locality and added not a little to the exceedingly uncomfortable swell. It occurred to me more than once that under certain conditions heavy tide rips or overfalls might be encountered, giving color to reported dangers.

Another sounding was taken 9′ south of Point Abaçou in 1,039 fathoms, and then a line run 30′ W. ¼ S. (mag.), sounding every 10′; then NW. ½ W. 13′, and SSW. (mag.) 53′, sounding at intervals of 15′, for the purpose of eliminating a large number of negative soundings appearing on the chart, also to examine two shoals referred to in H. O. publication No. 63, vol. 1, p. 226, as follows:

"More recent soundings of 16 fathoms have been reported in latitude 17° 45′ 00″ N., longitude 74° 39′ 00″ W., and also in latitude 17° 13′ 00″ N., longitude 74° 58′ 00″ W."

We found 803 fathoms within 3 miles of the former position and 1,120 fathoms on the position assigned to the latter, demonstrating conclusively that shoal water does not exist in the positions named. It is highly probable, however, that much less water may be found west and north of this locality. The wind and sea moderated as we left the coast, and we finally lost the easterly current.

From our last position we ran 15′ NNW. (mag.) and sounded in 968 fathoms, and then changed the course to N. by E. (mag.) for 70′, sounding at intervals of 15′ except in one case, when a sounding of the Blake intervened. A reference to this line will show the bottom to be very uneven in this locality, and a depth of 262 fathoms in latitude 18° 18′ 30″ N., longitude 74° 53′ 30″ W., about 10′ SE. by E. from Navassa,

is something of a surprise. The water deepens to 1,040 fathoms 15′ to the northward and eastward of the island, and to 1,347 fathoms 8′ NW. of Cape Dame Marie. From this point we ran E. by N. 60′, sounding at intervals of 20′, the second cast giving us 1,974 fathoms and the third 342 fathoms about 10′ to the westward of Gonaive Island. From this point we steamed N. by E. ¼ E. (mag.) 20′, where we found 800 fathoms, and 20′ W. by S. (mag.), 502 fathoms, which was of course a surprise. From this point we ran a line WNW. (mag.) 76′, sounding at intervals of 20′. The maximum depth found in the windward passage was 1,923 fathoms.

At 12.40 p. m., February 25, we sounded in 1,639 fathoms, green sand, latitude 19° 45′ 00″ N., longitude 75° 04′ 00″ W., took serial temperatures, and at 2.50 p. m. put the trawl over, veering to 2,400 fathoms, landing it on deck again at 6.35 p. m., having made a successful haul. There were a variety of sponges, some very large shrimp, one fish, numerous shells, small crabs, holothurians, and an interesting octopus, the arms all of the same length and connected by a membrane. The color was cherry-red on its head, becoming gradually darker towards the extremities.

After the trawl was on deck we started ahead, sounding at various intervals along the southern coast of Cuba during the night. The wind was light, with smooth sea. Heavy clouds hung over the island and frequent bright flashes of lightning were seen.

The light of Santiago de Cuba was sighted at 12.40 a. m., and the vessel was hove to soon after till daylight, when we steamed in and anchored in the harbor at 8 a. m., February 26. A boat was sent for the United States consul, John C. Landreau, who visited the ship. Boarding-officers were received from the Spanish iron-clad ram Sanchez Barcaiztagui, from the captain of the port, and health officer.

At noon, accompanied by the United States consul, I made an official call on the governor and the captain of the port, and at 1.30 p. m. I called on the commander of the Spanish ram, who returned the visit at 3 p. m. A mail was received from the consulate, provisions taken on board, and at 9.30 a. m. the following day we got under way, stood out of the harbor, and made ten hauls of the tangles in search of *Pentacrinus*. Several hauls were made before we succeeded in getting a specimen. Finally, however, after working until late in the evening, we procured four fine ones in perfect condition. We left the ground reluctantly, for we wished to procure a large supply, but the small amount of coal in the bunkers admonished us to be moving towards Kingston without further delay.

We ran a line SSE. ¾ E. (mag.) 93′ in the direction of Navassa, sounding at intervals of 10′ to 20′. The maximum depth, 2,275 fathoms, was found 44′ from Santiago de Cuba light-house. The soundings gradually decreased to 870 fathoms about 6′ from Navassa, from which point we ran a line W. ½ S. (mag.) 30′ sounding at intervals of 15′, the first cast giving 1,015 fathoms, and the second 620 fathoms, 7′ E. ½ N. from

Formigas Banks. A line was then run SSW. ¼ W. (mag.) 50′, sounding at intervals of about 12′. The greatest depth, 1,153 fathoms, was found midway between the banks and Morant Point, the last cast on the line giving 450 fathoms 10′ ESE. ¼ E. (mag.), from the light, which was in full view.

Having located the ship accurately with reference to the above-mentioned light, we started ahead at 4 a.m. running a line ESE. ¾ E. (mag.), sounding at short intervals, toward a shoal marked as follows on H. O. chart No. 35, "(8) shoal," and concerning which the following references are made in H. O. publication No. 63, pp. 226 and 227:

"Several reports have been received of banks in the windward channel. H. M. brig Renard in 1805 sounded in 18 fathoms for five miles on an easterly course on a bank considered to be 16 miles in length in latitude 17° 44′ 00″ N. and NE. 27′ from Morant Cays.

"Mr. John S. Holt, master of the brig Georgia, reports in 1867 that on his passage from Kingston, Jamaica, toward Navassa Island he sounded in 14 fathoms of water, and from the color of the bottom he judged that some places on the bank had as little as 8 or 10 fathoms of water. The position of the shoal he gives as latitude 17° 46′ 00″ N., longitude 75° 45′ 00″ W., Point Morant bearing by compass W. by N. 28 miles. There is doubtless a shoal in this vicinity, and the attention of navigators is called to the desirability of obtaining and publishing its exact position and extent."

Although the above positions differ somewhat from each other and from that found by us, they evidently refer to the same bank. We found 21 fathoms on the northern end of the shoal ESE. ½ E. (mag.) about 32′ from Morant Point light-house, in latitude 17° 44′ 00″ N., longitude 75° 50′ 00″ W. It is about 9′ in length NNE. ½ E. and SSW. ½ W., and from 3′ to 4′ in width. The least water found was 17½ fathoms.

After finding the shoal as mentioned above, we anchored a boat with a flag at her mast-head, and ran lines of soundings off and on until dark, when, owing to our nearly empty bunkers, we were obliged to start for port intending to complete the examination on our way to Savanilla. Leaving the southern edge of the bank, we ran a line W. by N. (mag.) 58′, sounding at intervals. The depth of water found the first cast (¾′ SE. of an 18-fathom sounding on the edge of the bank) was 360 fathoms, increasing to 838 fathoms 3½′ to the westward, the greatest depth on the line, 875 fathoms, being reached 4′ farther to the westward, from 400 to 700 fathoms being found throughout the remainder of the line. Port Royal light bore NNW. ½ W. (mag.) 7′ distant at the last sounding on the above line, which gave 484 fathoms. Another and the last cast before entering port gave 400 fathoms 2′ NW. by N. (mag.) from the position above-mentioned and quite near the bank. A course was then laid for the entrance, and we reached quarantine without difficulty. We were detained there about half an hour before satisfactory arrangements could be made in the absence of a bill of health, which we had omitted to procure at the last port. Our own certificate was

finally accepted and we went on to Kingston, where we anchored at 1.22 p. m. A boat was sent for the United States consul, George E. Hoskinson, who came on board. A visit was also received from an officer representing the commandant of the naval station at Port Royal, with offers of assistance. A large mail was received from the consulate. Immediate inquiries were made for coal, and at 9 a. m., March 3, we went alongside the English steamer Grip Fast lying at the coal wharf and coaled ship across her decks. At 1 p. m. I left the ship, and, accompanied by the United States consul, made an official visit to the governor, Sir Henry Norman, and at 2 p. m. lunched at King's House with the governor and his family. At 4 p. m. I called on the commandant of the naval station at Port Royal, the call being returned the following day by Lieutenant Swan, R. N., representing the commandant in his absence. We finished coaling at 3.15 p. m. and left the wharf, anchoring in the harbor. The fires were then hauled and repairs commenced on the boilers; other repairs were already under way, and having expended our sounding-shot, a fresh supply was ordered. At 1.50 p. m. March 5 the governor and aid-de-camp visited the ship and made a thorough inspection of the vessel and her apparatus.

The trades, which had been light since our arrival, increased to their full force on the 6th, and continued during our stay. The breeze would spring up between 8 and 9 a. m., attain its greatest force about 2 p. m. and the least about 7 or 8 p. m. A heavy swell came up with the wind, which made communication in the harbor with small boats rather a difficult matter. Our steam-cutter and gig, however, made us practically independent of wind and sea.

We usually had one or more showers during the day, and in Santiago de Cuba we had heavy rain. The showers continued in Kingston until the strong trades set in, when they ceased, and we had several dry days in succession, an unusual occurrence since our arrival in the Caribbean.

The naturalists were busily engaged collecting during our stay in port and found it excellent ground, the best in many respects that we had found in the West Indies.

Repairs on the boilers were finished March 10; engineers and paymaster's stores on board, and the sounding-shot, the last articles to complete our outfit, were received on the morning of the 11th, and at 11.40 a. m. we got under way and proceeded to sea. Arriving near the edge of the bank, we put the tangles over, but unfortunately they fouled on the bottom and were lost. We then ran a line of soundings S. $\frac{1}{4}$ E. 15′ at varying intervals, crossing the center of California Bank in 26 fathoms. At 6.40 p. m. we sounded in 966 fathoms, sand, latitude 17° 36′ 10″ N., longitude 76° 46′ 05″ W., and put the trawl over, landing it on the bottom at 8.20 and on deck at 10 p. m., after a successful haul. One rather remarkable specimen was a large earthenware jar, with its surfaces pretty well covered with worm-tubes. We steamed

about 5′ to the northward and eastward during the haul, and, starting from that point, ran a line directly to Morant Cays, ESE. ½ E. (mag.) 42′, sounding at short intervals. At 11.45 a. m., March 12, we anchored in 4 fathoms under the lee of Northeast Cay, and sent the whale-boat with the naturalists, in charge of Lieutenant May, with instructions to land if it could be done without risk, otherwise to return to the ship.

The trades were blowing fresh and a heavy swell set around the ends of the cay, causing a break on the beach that made landing impracticable without danger of staving the boat on the coral lumps. The temptation to land on this (to the naturalists) virgin soil was very great, but Lieutenant May, having in mind the safety of the boat, very wisely returned. Getting under way we ran a line of soundings in various directions from the cays to the shoal which we had examined on the 29th of February, and, although the sea was too rough to permit a more extended reconnaissance, we developed the fact that the bank referred to is an extension of Morant Cays.

At 8.35 p. m. we turned our head to the southward and ran a line S. by E. about 140′ to a group of negative soundings, in the midst of which we cast the trawl in 2,295 fathoms, latitude 15° 18′ 30″ N., longitude 75° 22′ 30′ W., then continued the line about SSE. ½ E. (mag.) in the direction of Santa Marta.

At 9.41 a. m., March 15, we sounded in 2,057 fathoms, on the position assigned a doubtful shoal, H. O. chart No. 36, in latitude 12° 11′ 30″ N., longitude 74° 27′ 30″ W., and, it is needless to say, failed to discover any indications of shoal water.

We then ran a line S. ½ E. (mag.) 60′, passing about 12′ to the westward of Santa Marta light-house, sounding at frequent intervals as we approached the coast, then stood off NW. ¾ W. (mag.) 35′, sounding at intervals of 15′, then S. ¼ W. for the mouth of the Magdalena River and Savanilla, anchoring off the latter place at 8.28 a. m., March 16.

We had strong winds to moderate gales after leaving Morant Cays, from E. to ENE. in the northern Caribbean, and NE. as we approached the Colombian coast. The heavy winds were accompanied by rough seas, making the work of sounding an exceedingly critical operation. The sounding-wire parted several times during the night of the 11th and morning of the 12th in a most unaccountable manner, lósing either lead or sounding-rod and a thermometer with more or less wire each time. We were inclined to blame the splices at first, but soon found that we must look further for the cause. In the meantime we changed reels, leaving the solution of the mystery until the following day, when, after reeling the wire off, the drum was found to be collapsed. The metal was neither broken nor cracked, but the center simply settled down on the bolts, the sides retaining their form. There would have been little or no harm arising from this had not the edges of the drum drawn away from the sides, leaving sufficient space for a turn or two of wire, which became so firmly fixed, when reeling in, that it would

part before clearing itself while sounding. I think this condition was not caused by any sudden strain, but that it has been gradual, from the fact that we have been troubled with slack turns from time to time when taking very deep soundings.

The instructions of the Bureau of Navigation contemplated the examination of the bar at the mouth of the Magdalena River, but we found it impracticable to accomplish anything with ship's boats at this season of the year, when the trades are at their height. The worst sea we have encountered during the cruise was a few miles to the northward of this bar.

I went to Barranquilla on the morning of the 17th, called on the United States consul, Thomas M. Dawson, esq., and with his assistance had interviews with ship-masters, steamship agents, &c., with reference to the conditions and character of the bar.

From the information obtained and from personal observation, my opinion is that a survey with ship's boats is impracticable during the winter months; May and June being the most favorable. Examinations may, however, be made at any time with a sea-going tug of moderate draught. A survey of the bar would be of no commercial benefit after the expiration of a few weeks. Vessels drawing eight feet of water or less may enter at any time with comparative safety, simply keeping clear of the breakers; with from 8 to 12 feet draught it would be prudent to examine the bar before entering, and for greater draught an examination is imperatively necessary before attempting to cross.

In 1875 the bar cut away, giving about 30 feet, and steamers began to cross and ascend the river, continuing to do so until 1880, when, owing to the risks of grounding on the bar or detention in the river, they discontinued the practice, and now all anchor at Savanilla, or Salgar, as it is locally called.

Merchandise descending the river must be transhipped from the river steamers to the railway at Barranquilla and transported about 12 miles to Salgar, where it is transferred to lighters, which are towed about 3 miles to the shipping at Savanilla anchorage. There are no facilities for the rapid handling of freight, and with but five lighters to transport the cargoes of seven steamship lines calling regularly at the port, it is no matter of surprise to see vessels detained a week or more, losing valuable time and frequently missing connections.

The Government of the Republic and the people of Barranquilla realize the necessity of providing a more practicable outlet for their great river, and with this end in view surveys have been made for a deep-water terminus of the Bolivar Railway. At a new harbor recently surveyed, called Puerto Belillo, a pier is projected where steamers can lay alongside and discharge into cars or receive freight from them direct. There is 30 feet of water at the end of the pier and 26 feet 200 feet inside. The length of the extension is about 5¾ miles on level ground, with no serious engineering difficulties, and the harbor is easy of ap-

proach, perfectly protected from the prevailing winds, and of ample size for the present or future commerce of the port. This, it seems to me, is the most practicable and economical method of solving (what is to Barranquilla in particular) a vital problem, the total estimated expense for extension and pier being only about $1,000,000.

The trades were blowing fresh during our stay, getting up a considerable swell between the anchorage and railway terminus, thus making communication with ordinary ship's boats very tedious. Here again we had reason to appreciate our admirable little steam-cutter, which enabled us to come and go at pleasure.

On the 19th instant, accompanied by the United States consul and vice-consul, I made official visits to the President of the State (who was in Barranquilla at the time), the governor, and military commandant.

We left Savanilla at 8.15 a. m. on the 22d, and ran a line of soundings W. ¾ N. (mag.) 52′ to the position in which the U. S. S. Powhatan reported shoal water, latitude 11° 11′ 00″ N., longitude 75° 50′ 30″ W., where we found 1,175 fathoms, the water having deepened regularly since leaving port. From this point we ran a line S. ½ E. (mag.) 40′, and being then 16′ W. by N. (mag.) from Cartagena light-house, in 825 fathoms, we stood off shore WSW. (mag.) 43′, then SSE. (mag.) 51′ to a point 7′ NW. ½ N. of Fuerte Island, where we found 38 fathoms. Soundings were taken at intervals of 10′ to 15′ since leaving Savanilla, and in running the traverses off and on shore, the change in the depth was gradual, making it extremely improbable that shoals exist outside of the shore reefs.

At 3.30 p. m. we started on a line W. ¼ N. (mag.), sounding at intervals of 5′ to 20′ while crossing the bay at the south of which lies the Gulf of Darien. At 4 p. m. we cast the trawl in 42 fathoms, green mud, latitude 9° 30′ 15″ N., longitude 76° 20′ 30″ W.; and at 4.55 another haul was made in 155 fathoms, green mud, latitude 9° 30′ 45″ N., longitude 76° 25′ 30″ W., both hauls furnishing us a small number of good specimens.

Strong trades and a heavy sea followed us till we passed Cartagena, when the wind died out and the sea moderated, causing a marked change in the motions of the vessel, which was duly appreciated by all on board.

The line was continued sounding at various intervals to Aspinwall, where we arrived at 2.55 p. m. March 26. A boat was sent for the United States consul, but the dispatching of a steamer which was to sail during the afternoon prevented his coming on board. He sent off word, however, that several deaths had occurred recently from what had been called malignant malarial fever, but which, in his opinion, was yellow fever. Pending further investigations orders were given that there should be no communication with the shore, except when it was absolutely necessary in carrying on the ship's duties.

Dr. Herndon made inquiries the following day and satisfied himself that the cases referred to were yellow fever; and although he was unable to learn of the existence of any cases at that time, he advised every possible precaution. We followed this advice as strictly as possible, no one leaving the ship except on duty.

On the morning of the 27th we went alongside of a vessel just arrived from Liverpool with coal for the Pacific Mail Steamship Company, and took on board 60 tons, returning to our anchorage in the evening. The strict quarantine observed prevented the naturalists from making collections at this port, which I expected would be the most fruitful, owing to the facility with which they could reach the interior by the railroad. Ensign A. A. Ackerman was detached by telegraphic orders from the Navy Department, and subsequently assigned to duty in the Greely Relief Expedition. His departure restricted the scope of our investigations, as he had charge of the departments of botany, geology, and mineralogy. Necessary repairs on the boilers detained us several days after we were in other respects ready for sea. The quarantine having been maintained until we departed, there was little opportunity for collecting specimens. Such as could be taken from the ship were, in fact, the only ones secured.

We left Aspinwall at 9.30 a. m., April 2. Steaming out about 5 miles from the anchorage, we put the dredge over in 25 fathoms, with slight success, the bottom being apparently smooth and hard, where we expected mud. Thinking the trawl might do better, we put it over, about 5 miles to the northward, in 34 fathoms on smooth bottom, but soon dragged on to foul ground, where it caught frequently, and, after heaving it up, we found the net a wreck, but the bag still held a large variety of corals, sponges, fish, crabs, ophiurans, &c., three or four fine specimens of free crinoids being considered special prizes by Mr. Benedict. The tangles, with a boat-dredge attached, were put over in 130 fathoms about 2 or 3 miles from the latter position, but came up perfectly clean, indicating a smooth, hard bottom, or a mud so thin that it all washed through the dredge-net.

After the tangles were up, a line of soundings was started NNW. ½ W. (mag.) for Old Providence Island, about 240 miles distant. Casts were made at intervals of 10 to 25 miles. Starting with 707 fathoms, 17 miles from Aspinwall, the water shoaled to 611 fathoms at 27 miles, reaching the maximum, 1,900 fathoms, 77 miles from port, then shoaled gradually to 339 fathoms close to the reef off the SW. end of Old Providence. We made the island at 8.30 a. m. on the 4th, and anchored in Catalina Harbor at 3.50 p. m.

We called here for the double purpose of procuring supplies and giving the naturalists an opportunity of examining the fauna of this isolated island. I wished also to give the officers and crew an opportunity to stretch their legs on shore after their long confinement on board, very few of them having been out of the ship since leaving Kingston.

This was in old times the favorite resort of buccaneers, and the ruins of their fortifications, even some of their ancient cannon, are still to be seen. A glance at the beautiful little harbor of Catalina and its surroundings reveals the wisdom of its selection as a rendezvous by the lawless freebooters. The island is entirely surrounded by dangerous reefs, and the entrance to the harbor is narrow, somewhat tortuous, and was commanded by their batteries on shore. Ample supplies of wood, water, fresh meats, fruit, and vegetables were procured from the inhabitants, with whom they made it a point to be on friendly terms. Its location near to but outside the great routes of commerce made it particularly valuable for their purpose.

The island belongs to the United States of Colombia, and has a population of about 800, the Indian blood predominating, but there is a large African element. The English language is universally spoken, and the Protestant religion is the only one professed by the people. Schools are maintained, and it is the exception when a native is unable to read and write.

There is no physician on the island, and the lack of proper medical attendance causes great suffering among the inhabitants. Dr. Herndon had a room fitted up on shore, and gave his whole time to the sick who came or were brought to him, the ship furnishing such medicines as could be spared. As soon as we anchored, an officer was sent on shore to call on the magistrate and inform him of our mission. He received the officer very cordially and offered every assistance in his power. The naturalists began work at once and succeeded in making a very creditable collection. Quite a large variety of fish were procured for specimens, and an ample supply for officers and crew was caught with the seine. Fresh beef, poultry, sweet potatoes, yams, and fruit were plentiful at fair prices. Tortoise-shell and cocoanuts are articles of export. The climate during the dry season, from November to May, is tempered by the trades, which blow constantly, and is probably unexcelled by that of any island in the West Indies.

We left the harbor at 6 a. m. on the 9th instant, and, after clearing the reef, laid a course of NNE. $\frac{3}{4}$ E. for a doubtful bank 109′ distant, in latitude 14° 53′ 00″ N., longitude 80° 20′ 00″ W., sounding at intervals of about 11 miles. We put the tangles over, with a boat-dredge attached, in 382 fathoms, latitude 13° 34′ 45″ N., longitude 81° 21′ 10″ W. The tangles came up quite clean, but the boat-dredge was filled with a compact mass of white ooze, very rich in foraminifera. The water increased gradually in depth to 1,151 fathoms on the reported bank where it was supposed to break at times. The sounding was made at 4.30 a. m. on the 10th instant, and the spot carefully located by astronomical observations before leaving it. The soundings were quite regular, but, to make a sure thing of it, we sounded 5 miles to the southward of the position in 1,069 fathoms, and again 6 miles to the northward in 971 fathoms, after which we changed the course to NW. by N. (mag.),

sounding at varying intervals, the water shoaling gradually to 511 fathoms 15 miles from the eastern edge of a bank lying between Thunder Knoll and Rosalind Bank. We crossed the bank before mentioned in from 19 to 24 fathoms, coral, and laid a course NW. ½ W. (mag.), for a vigia, marked on H. O. chart No. 394 in latitude 18° 30′ 00″ N., longitude 83° 16′ 00″ W., sounding at intervals as usual.

The trawl was lowered at 1.22 p. m. in 653 fathoms, yellow ooze, latitude 15° 28′ 30″ N., longitude 80° 36′ 00″ W. Serial temperatures and water specimens were taken to 500 fathoms. A few deep-sea fish and small crustaceans were all that were brought up, the bottom being almost destitute of marine life.

Several boobies (*Sula*) were flying around the ship, and finally one of them alighted on the forecastle, when it was caught by one of the men, who, after amusing himself and shipmates awhile, tossed it overboard, expecting it would take itself off as quickly as possible; but, to our surprise, it returned immediately, alighting on the rail where nearly every man of the crew had congregated to watch its performance. It did not seem to be distressed in any way, and went deliberately to work rearranging its plumage, which had been somewhat ruffled by handling, calmly surveying the noisy crowd of men gathered around it. They tried to feed it, offering everything that could be found, but nothing seemed to suit its taste. It would not submit quietly to being handled, but made no attempt to fly away, and, although tossed overboard six times during the afternoon, it returned as often, invariably alighting in the same place among the men, where it finally took up its quarters for the night, remaining till 6 o'clock the following morning, when it left without ceremony and was not seen again. I relate this incident, as it is the first instance of the kind in my experience at sea.

The line of soundings was continued during the 11th, the depth increasing gradually to 920 fathoms 75 miles from Thunder Knoll, then dropped off to 3,169 fathoms at 105 miles. This was the greatest depth found in the Caribbean, and the sounding was made under adverse circumstances. On the first trial, the stray-line parted after something over 200 fathoms had run out, the sounding-rod, water-bottle, and shot being lost. It is difficult to explain this accident unless we lay it to a shark or some other fish, as the strain on it at the time did not equal one-tenth of its tensile strength. On the second attempt, all the wire was run off the reel without reaching bottom and the shot had to be reeled in; more wire was added, and finally the sounding was taken. The bottom was a light yellow ooze, with only a trace of foraminifera, resembling in this feature the bottom at our greatest depth near the breakers reported by H. D. M. S. Ancon.

The currents, which had been light since leaving Old Providence, became strong and irregular. At 5.25 on the morning of the 12th we sounded in 2,829 fathoms on the position assigned to the vigia abovementioned, which is 66 miles from the deep sounding of the previous

day. While making this distance and taking two intermediate soundings we were so beset by strong and erratic currents that it was only by locating each position astronomically that we could keep near the desired locality.

If these currents were encountered by other navigators who were steering a course without taking hourly observations, a very brief period would be required to take them sufficiently out of their reckoning to account not only for the vigia mentioned, but the soundings of H. B. M. S. Phœbe and Rosario to the eastward of Misterioso Bank, which was itself doubtless reported in a multitude of positions before it was finally located on the charts of to-day.

Having sounded on the position of the vigia, we stood for Misterioso Bank, which we crossed in from 12 to 14 fathoms, coral. We found 708 fathoms about three miles east of the bank, and 891 fathoms 2½ miles to the westward. From this point, a course NNW. ¼ W. (mag.) was laid for Cape San Antonio, 189 miles distant, soundings being taken until we passed the light on the evening of the 13th, when a course was laid for Key West, Fla., where we arrived at 7.15 a. m. on the 15th instant. It was our intention to search for shoals reported off Cape San Antonio, but our coal running short, we were obliged to make the best of our way to port.

We finished coaling on the evening of April 17, and were detained in port till the 27th repairing boilers.

There were no boiler-makers to be found in the place, but with the facilities of the Government machine-shop, which the commandant of the station, Lieut.-Commander George F. F. Wilde, U. S. N., placed at our disposal, we were able to do the work with our own men.

We reeled on a thousand fathoms of new dredge-rope while in port, all the reel would hold, in fact, and made several tangle-bars and a large supply of swabs preparatory to a search for *Pentacrinus* on our return to the Cuban coast. The ground is said to be very foul where they are found; so we went prepared to lose any amount of gear and still be in working order.

We left Key West at 4.40 p. m., April 27, arriving in Havana at 6.20 the following morning, and moored to one of the government buoys. The health officer came alongside and gave us pratique, and officers from the captain of the port and the Spanish flagship Jorge Juan called to offer the usual courtesies. An officer was sent to call on the acting consul-general, Clarence C. Ford, to inform him of our arrival and request him to make an appointment to call on the captain-general.

During the morning I called on the admiral, Florencio Montajo, and the commander of the flagship; the latter officer returning the call later in the day, and the fleet-captain returning the call on the part of the admiral the following morning. At 11 a. m. the same day I made an

official call on the captain-general, accompanied by the acting consul-general and Lieut. A. C. Baker, of this ship.

During the interview I took occasion to inform the captain-general that we wished to make some deep-sea explorations in the immediate vicinity of the harbor, and, after completing this work, to examine the region about Cape San Antonio in order to determine the existence or non-existence of Sancho Pardo Shoal, which had been reported from time to time since 1606. I mentioned also that it was desirable to observe the longitude of Cape San Antonio.

The captain general very kindly informed me that we could do anything we wished on the coast of Cuba, and we subsequently learned that he sent orders to Cape San Antonio that we should be permitted to land and take observations for longitude.

At 12.45 p. m. there were three heavy explosions in the city, following in rapid succession. Dense volumes of smoke obscured the view, and the concussion was very heavy even on board ship. The first explosion was a magazine in the arsenal, and the others, which were a gasometer and another magazine, were caused by concussion or falling fragments. There was serious loss of life, and great damage was done to buildings in that section of the city. A panic followed, which in the narrow crowded streets resulted in much personal injury.

At 5.30 a. m. on the 30th we left our moorings and stood out of the harbor. At 6.05 we sounded in 387 fathoms, 2 miles NW. of Morro Castle, and put the tangles over for *Pentacrinus*. We had poor success during the forenoon, but later in the day were more fortunate. Twelve hauls were made over very rough coral bottom, the tangles fouling nearly every haul, but we succeeded in clearing them till the last cast in the evening, when we were obliged to break the rope, losing 110 fathoms, besides the tangles and weights. We were well satisfied with the day's work, notwithstanding the loss, and at 5.20 ran into port, taking up our former berth.

The morning of May 1 opened with light easterly winds, clear weather, and smooth sea. At 5.48 a. m. we left our moorings and steamed out of the harbor. Our experience of the previous day enabled us to select good working ground at once, and after 6 hauls, which were finished at 11.30 a. m., we started for Cape San Antonio, having procured a fine lot of *Pentacrinus*, as well as a good general assortment of specimens. Although the bottom was exceedingly rough and the tangles fouled at every haul, we were fortunate enough to lose no more gear. The immunity from loss was due in a great measure to the promptness with which the engine signals were obeyed.

At 3.40 p. m. we sounded in 625 fathoms, latitude 23° 06′ 00″ N., longitude 83° 05′ 45″ W., on the position assigned, in H. O. chart, No. 576, to the shoal reported by the Hattie Weston in 1880. There is no doubt as to this vessel having been on a reef, but it was the shore reef and not an isolated or outlying danger. I have no knowledge of the

methods adopted by the Hattie Weston for locating the shoal on which she struck, or whether her position was entirely by dead-reckoning. Assuming the latter to be the case, her probable position was on the reef to the westward of Bahia Honda.

It is a well-known fact that strong southwesterly currents are encountered between Havana and Cape San Antonio. I have myself experienced from half a knot to two knots per hour, and on one occasion it was setting so much on shore that I found it necessary to head off one point and a quarter at an average speed of about 12 knots under steam. Had we laid a course parallel with the reef, even with a good offing, we would have found ourselves in shoal water in a few hours, when by our reckoning we should have been at a safe distance off shore.

There is a note on H. O. chart No. 516 with reference to Colorado Reefs, which reads as follows: "These reefs are reported to extend further out." The prevailing current setting inshore has doubtless given rise to the note quoted above.

We made Cape San Antonio at 8 a. m. the following morning and commenced the work of sounding. The plan adopted was to run lines on and off shore, keeping the light-house on a certain bearing, and sounding at intervals varying from half a mile to two miles. The distance from the light-house was measured by a micrometer telescope whenever the elevation of the landmark would permit, and by a taffrail log when too far off shore to use the telescope. The run by log was checked by the first micrometer distance when approaching land. The bearing of the light-house was changed about one point for each line of soundings, varying somewhat when necessary to pass over the various positions assigned to Sancho Pardo Shoal, for which we were searching. The micrometer telescope was not available at night, but the run was checked at each end of the line offshore by the range of visibility of the light and inshore by the reef. The correct bearing of the light was maintained usually with little difficulty, although at times, particularly near the shore, the currents were so strong that without careful watching the vessel would change her bearing very rapidly.

The above-mentioned plan was adopted from necessity, as, owing to the peculiar form of the land near the cape and the fact that it is laid down incorrectly on the charts, cross-bearings were out of the question except at a very few of the stations.

Having run the first line inshore S. by E. (mag.), we stood off NNW. (mag.), and at 10.48 a. m. struck $15\frac{1}{2}$ fathoms on Antonio Knoll, latitude 22° 00′ 42″ N., longitude 85° 02′ 00″ W., the latitude being obtained by meridian altitude of the sun with two observers and the longitude by bearing from the light-house. A boat was anchored in the above position and the shoal developed by the ship, $14\frac{1}{2}$ fathoms being the least water found. The center of the knoll lies NNW. $\frac{1}{2}$ W. (mag.) 9 miles from the light-house, and is about $2\frac{1}{2}$ miles in length SW. $\frac{1}{2}$ S. and NE. $\frac{1}{2}$ N. by 1 mile in width. A depth of 10 fathoms has been reported on the knoll,

and although we failed to find it, I have no doubt that the reports are correct. The formation is coral and the whole surface very uneven, as shown by our soundings.

At 2.50 p. m. we hoisted the boat and continued the lines off and on shore until we pretty well covered the ground to the westward of the light. With the exception of Antonio Knoll, we found the water to deepen gradually as we left the reef until the thousand-fathom line was reached, from 15 to 20 miles off shore. There were 1,149 fathoms on the position originally assigned Sancho Pardo Shoal in 1606, and not less than 500 fathoms in any of the half-dozen localities in which it has been subsequently reported. I have no doubt that vessels found themselves unexpectedly in shoal water when by their reckoning they were in the several positions assigned to the shoal; but no navigator familiar with the strong currents in the region off the cape, after having examined our soundings, will find it difficult to connect them with Antonio Knoll, or even the Colorado Reefs. The remarkable distinctness with which the numberless coral growths can be seen on Antonio Knoll, through the clear blue waters of the Gulf, contributed, doubtless, in no small degree toward the erroneous impression that they were in much shoaler water than really existed in that locality.

The weather could not have been more favorable for our work, which was carried on day and night until the evening of the 4th, when we anchored near the Leña Cays. The longitude of Cape San Antonio lighthouse was obtained the next day by Lieutenant Schroeder, several sets of equal altitude of the sun being taken, and the meridian distance carried to Key West.

The height of the tower above the ground is 23.1 meters; height of base of tower above mean sea-level, 18 meters; height of light above mean sea-level, 39 meters; revolving light; period of brilliancy, 6 seconds; partial eclipse, 24 seconds; power of light, 1,440 carcel burners; longitude (Lieutenant Schroeder), 84° 57′ 38″ W., and is 100 yards from the beach.

The navigator returned at 5 p. m., and at 7 we got under way and ran a line of soundings NNW. (mag.) 20 miles from the light, where, according to the light-house keeper, the shoal had been reported. The depths increased gradually from Antonio Knoll to nearly 1,000 fathoms at the distance above-mentioned, which, taken in connection with depths on contiguous lines, makes the existence of a shoal in that position wholly impossible. We finished the soundings and started for Albatross Shoal at 1 a. m., and at 8.43 cast the lead a short distance outside of the reef in 388 fathoms, latitude 22° 41′ 20″ N., longitude 84° 15′ 00″ W. (mag.), then run 4 miles N. ½ W. (mag.) and sounded in 817 fathoms, then 4 miles further on the same course and sounded in 950 fathoms on the position assigned to the shoal on H. O. chart No. 516, latitude 22° 49′ 20″ N., longitude 84° 15′ 00″ W. We then run 4 miles E. ½ N. (mag.) and sounded in 801 fathoms, after which a course was laid for

Key West. The above positions were accurately obtained by cross-bearings of well-known points on shore, and the results of the three soundings show conclusively that no shoal exists in that locality.

We arrived at Key West at 5 a. m. on the morning of the 7th and anchored near the quarantine station. We were visited by the health officer between 8 and 9 a. m., and at 11 a. m. went alongside the coal wharf. The fires were hauled and boilers blown down preparatory to making temporary repairs, and at 1.30 p. m. we commenced coaling, and finished about 9 a. m. on the 8th, having taken on board $61\frac{1867}{2240}$ tons of anthracite coal.

At 2 p. m. on the 10th we got under way and stood out to sea, bound for Washington, D. C.

At 7.52 a. m. on the 12th we sounded in 470 fathoms, latitude 30° 46′ 00″ N., longitude 75° 35′ 00″ W., on the position of Huntley Shoal, H. O. chart No. 21, reported in 1833.

We then stood for another shoal, marked on H. O. chart No. 21. At 6 a. m. on the 14th we sounded in 2,537 fathoms, latitude 34° 14′ 00″ N., longitude 72° 35′ 30″ W., and at 5.12 p. m. sounded in 2,462 fathoms, latitude 34° 48′ 45″ N., longitude 72° 25′ 00″ W., on the position assigned to Orion Shoal.

This sounding completed the work planned for us; and we then made the best of our way to Washington, where we arrived at 4.10 p. m. on the 16th instant; hauled fires on the 17th, and commenced the work of refitting, preparatory to the summer's cruise.

The deck-house, forecastle, and poop-decks were caulked; otherwise there was but little to do to the vessel proper, except the usual cleaning, painting, &c. There were some slight repairs on the Sigsbee sounding-machine, and a supply of tangles and trawl-frames were made at the navy-yard. The Tanner sounding-machine was repaired at small expense. The galley required repairs to the extent of $5. It has given general satisfaction since the last improvements were made, and I have reported the fact to the Chief of the Bureau of Equipment and Recruiting, according to an agreement made when it was ordered.

The principal expense in time and money was on the boilers. The engines, pumps, and various special machinery required only the ordinary overhauling, being, as a rule, in excellent condition. The repairs on the boilers were completed on the evening of July 11, and at 4 p. m. the following day we left the yard and steamed down the Potomac, anchoring near Quantico for the night. We were under way again at daylight and anchored at Hampton Roads at 7.30 p. m. the same evening, going to the navy-yard, Norfolk, Va., early on the morning of the 14th, and into the dry-dock at 11 a. m., orders having been sent from the Navy Department to have the dock ready for us at that time. The water was pumped out of the dock during the afternoon, and on the following day most of the scraping was done and the first coat of paint was put on one side. The other side was finished the following day,

and on the 17th the second coat was put on. The vessel was hauled out of the dock and to the coal wharf at 2 p. m. on Friday, when we commenced coaling, finishing at 2 p. m. the following day, having taken on board 131 tons. We left the yard at 6 p. m. the same day and proceeded to sea. After passing the Capes we steamed off shore, keeping a lookout for surface fish, particularly menhaden and mackerel. In watching the migrations of these fish, our cruising ground last year was between the inner edge of the Gulf Stream and the coast, from the Capes of the Chesapeake to Cape Hatteras. To the northward of the Chesapeake our operations were confined mostly to the immediate vicinity of the coast, except, of course, our cruises to the Banks and the Gulf of Maine. Taking up the offshore search to the eastward of the Capes, we continued it between the northern edge of the Gulf Stream and the 100-fathom line as far as the meridian of Block Island. The only surface fish seen were two small schools of menhaden near the Capes of the Chesapeake, a school of porpoises, and two dolphins, which were in pursuit of small fish.

On the morning of the 20th, in latitude 37° 47′ 00″ N., longitude 74° 15′ 00″ W., near the 100-fathom line, we passed numerous dead octopods floating on the surface. This unusual sight attracted immediate notice and no little surprise among those who knew their habits, as it was not suspected at first that they were dead. We lowered a boat and picked up three or four specimens, which we were unable to identify, but in general appearance they resembled *Alloposus mollis* (Verrill) of unusually large size. These dead cephalopods were seen frequently on the 100-fathom line and outside of it from the position given above to the meridian of Montauk Point, a distance of 180 miles. They were less numerous, however, as we went to the northward and eastward. Several dead squid were seen also, and two specimens were picked up with a scoop net. The occurrence recalls the great destruction of tile-fish in the same locality during the winter of 1882. Three hauls were taken with the trawl during the day between latitude 37° 50′ 00″ and 38° 01′ 15″ N., longitude 73° 53′ 30″ and 73° 44′ 00″ W., in from 155 to 568 fathoms, and, although we found the bottom unusually barren, many valuable specimens were procured. Among them were large quantities of quill-like worm tubes, some beautiful specimens of flabellum, free crinoids, shrimp, a few large crabs, large flat sea-urchins, shells, foraminifera, and the usual quantity of deep-sea fish (*Macruridæ* and *Gadidæ*). A set of serial temperatures and water specimens were taken. We steamed about thirty miles to the eastward during the night, and at 4 a. m. on the 21st sounded in 1,600 fathoms, took a set of serial temperatures and water specimens, and at 6.25 a. m. put the trawl over in latitude 37° 57′ 00″ N., longitude 72° 34′ 00″ W., and landed it on deck, after a successful haul, at 10.50 a. m.

We then steamed to the eastward thirty miles, and at 2.59 p. m. sounded in 1,594 fathoms, globigerina ooze, latitude 38° 15′ 00″ N.,

longitude 72° 03′ 00″ W.; and at 3 p. m. put over the beam-trawl, veering to 2,300 fathoms of rope. It was on the bottom at 5 p. m., dragged until 6.20, and was landed on deck at 7.52 p. m. Among the specimens taken were a large number of holothurians, new to us last year; large numbers and great variety of starfish, sea-anemones, hermit-crabs, flounders, and other deep-sea fish. The trawl came up after dark the last haul, and the specimens were collected from the table-sieve by aid of the arc light. The vessel was put under very low speed for an hour for surface towing.

On the morning of the 22d we sounded our way into the remarkable hole referred to during our last year's cruise, and at 7.52 a. m. we cast the lead in 452 fathoms, green mud, latitude 39° 33′ 00″ N., longitude 72° 18′ 30″ W., took a set of serial temperatures and water specimens, and at 9 a. m. put over the small beam-trawl. Four hauls were made during the day between the position given above and latitude 39° 29′ 00″ N., longitude 72° 05′ 15″ W., in from 87 to 452 fathoms. In addition to our catch of the previous day, we took quite a number of pole-flounders and a large proportion of deep-sea fish. At 6.50 p. m., having finished dredging for the day, we hove to and drifted until 4 a. m. the following morning, when we sounded in 510 fathoms, black mud, latitude 39° 30′ 10″ N., longitude 71° 50′ 00″ W., and at 4.35 put over the beam-trawl. Four hauls were made during the day between the above position and latitude 39° 25′ 30″ N., longitude 71° 44′ 00″ W., in from 510 to 861 fathoms, with very satisfactory results. Among the many valuable specimens taken was a large cephalopod, genus *Eledone;* about 50 large red crabs, *Geryon quinquedens* (Smith), which we found last year; many shrimps; a small cephalopod, genus unknown; and an unusually large number of fish, mostly *Macrurus*, other varieties being, however, well represented. A set of serial temperatures and water specimens were taken after the last haul. The water specimen from 500 fathoms requires special mention from the unprecedented amount of gas it contained. When placed in the specific-gravity cup the escape of gas was perceptible to the eye and the rapid rising of bubbles made it impracticable to obtain the specific gravity for the moment. The operator, noticing the peculiarity, turned the water into a specimen bottle and sealed it as soon as possible, and even then after the loss of a large quantity of gas, it had very much the appearance of soda-water. This was so remarkable that we immediately sent down three water-bottles and thermometers, the specimens showing a large quantity of gas, but nothing like the former one. The ship had drifted about $\frac{1}{4}$ of a mile between the taking of the first and second specimens. The temperatures were uniform at 40° F.

It will be recollected that we experienced great difficulty in taking serial temperatures during the winter cruise in the Caribbean Sea from the mercury shaking down and filling the tubes of the Negretti & Zambra deep-sea thermometer. We used what is known as the Tan-

ner case and Sigsbee clamp, by which the thermometer was secured rigidly to the sounding-wire or temperature-rope, thereby transmitting all vibrations to the instrument, causing the mercury to shake down, as before mentioned. With a view of overcoming this difficulty we suspended the thermometer in its metal case by a rubber-lined thimble and delicate spiral spring at each end, allowing it a free vertical movement, intended to absorb all vibrations or jars resulting from surging of the temperature-rope or other causes incident to service under the various conditions of wind and sea. We have taken a large number of temperatures this trip, without a single failure, from causes above mentioned, and congratulate ourselves on our success in overcoming what has been to us a serious obstacle to the rapid and successful observation of serial temperatures.

At 6.35 p. m. we started for Montauk Point, under steam and sail, the weather clear and pleasant, with a brisk SW. breeze, but during the evening a heavy bank rose from the northward, and at 10 p. m. the wind came out from that direction, making it necessary to take in sail. The sky was overcast with drizzling rain during the latter part of the night, and after daylight a thick fog set in, which continued until we passed Montauk Point, about 6 a. m., when it cleared up and we proceeded to Napeague Bay, anchoring at 7.45 a. m. An officer was sent to the Excelsior Oil Factory to collect information regarding the menhaden fishing during the present season. He was cordially received by the superintendent, who made the following statement: "This factory employs two working gangs, running the works night and day. Two steamers are employed, and double the number of fish have been taken this season that were caught last year. All the factories in Promised Land are doing equally well. Last year 1,143,000 fish were taken by the two steamers up to July 24, and the present season one boat has taken 2,500,000; the other one, being temporarily disabled, has not made so good a record. The fish were taken from Fire Island to the eastward, also in Long Island Sound, where an ample supply has been found, making it unnecessary to go to the New Jersey coast as we have usually been obliged to do. They are very large and fat, those from Long Island Sound averaging from 7 to 8 gallons of oil per thousand, and those from the south coast of Long Island from 4 to 5 gallons per thousand. We have as much oil now as we made all last season. All the factories of any account in Long Island Sound are in operation this year; namely, seven in Promised Land, two in Sag Harbor, and two in Shelter Island. Edible fish are frequently taken in small numbers with menhaden, and sharks are very troublesome, particularly this season, large numbers of them getting in the seine at times. Mackerel were seen in schools off Shinnecock early in June."

The boat having returned to the ship we got under way at 10.30 a. m., and steamed to Block Island, anchoring at 2.25 p. m. An officer was sent ashore and called on Mr. Nicholas Ball, who stated that the mack-

erel fishing was much better than usual on the Block Island ground. The first fish were taken on the 10th of June. Cod and striped bass are scarce, but swordfish are very plentiful. Bluefish are also taken in large numbers. Fishermen are making from seven to eight dollars a day.

We left Block Island at 3.30 p. m. and anchored at Newport at 5.48 p. m. Several fishing schooners were cruising near Point Judith and between there and Newport, but none of them had boats out. We saw no fish on the trip.

It was our intention to leave port at daylight the following morning, but were detained until 11.40 a. m. by thick rainy weather. It cleared at that time, however, and we got under way and proceeded to sea. We passed seven fishing steamers between Brenton's Reef light-ship and Point Judith; several of them had boats out, and menhaden seemed to be plentiful. We saw at least a dozen schools.

No fish were seen outside of the latter point, except two small schools of tinker mackerel between Block Island and Cox's Ledge. At 2.45 p. m. we cast the lead in 21 fathoms, coarse sand, on this ledge, and put over a couple of cod lines to try for fish. A cod was taken as soon as the line reached bottom, and the order was then given to put the lines out. About twenty were used by the officers and crew, very few of whom were expert fishermen. Nevertheless, fish began to come in quite rapidly, and after two hours' work we had taken 85 cod, the largest weighing 25½ pounds, 13 hake, 3 pollock, 1 deep-sea perch, and 4 sculpin. They were placed in a large dredging-tub as soon as caught and a stream of water from the steam hose turned into it, keeping them alive. After we stopped fishing, Mr. Benedict carefully examined the catch for parasites, finding quite a large number. We caught 35 cod on this ground the 23d of October, 1883, and made a careful search for parasites, but failed to find even a single specimen, which would seem to indicate that the season of the year had some influence on the presence of these pests. Before leaving the fishing-ground we put a small beam-trawl over, intending to tow it rapidly through the water near the bottom, in order to test the practicability of taking fish in that manner. Unfortunately for the success of our experiment, we veered too much rope for the speed we were making, and the trawl took the bottom, caught on some obstruction, and parted the dredge-rope. There were several small schooners in the vicinity during the afternoon fishing for swordfish. We saw one large fish and sent a boat after it, but it disappeared before they reached the spot where it was seen.

At 5.15 p. m. we stood inshore and anchored in Tarpaulin Cove for the night. We were under way again at 4.45 a. m. on the morning of the 26th, arriving in Wood's Holl at 5.58 a. m.

The machinery, including the motive power, dredging and sounding engines, electric apparatus, &c., worked satisfactorily. The boilers, however, still gave us trouble.

The weather was squally and rainy until the 29th. The repairs to the boilers were completed on the 28th, and steam raised preparatory to going to sea. It was our intention to make a trip to the tilefish ground, but failing to procure bait we were detained in port over night, and the following day being thick and rainy we remained at our moorings until 9 a. m. July 31, when we left for Newport to procure menhaden for bait, and arrived there at 1.20 p. m.

On our arrival a telegram was received from the Chief Signal Officer, informing us that bad weather might be expected; and, as our principal work would be in boats, we decided to remain in port until the storm was over.

We left Newport August 1, having procured a supply of fresh menhaden, and stood to the southward. At 3.40 p. m. we hove to on Cox's Ledge and fished about two and a half hours with hand-lines, meeting with indifferent success. Large numbers of hake and dogfish were caught, but only a few cod. After the lines were in we put over the circular towing-net, having a ring ten feet in diameter and twenty feet length of net, to try rapid towing near the bottom for fish. We steamed at the rate of about five knots per hour for half an hour and hauled it in. There were no fish in the net, but a few starfish and shells showed that it had reached bottom occasionally. At 7.37 p. m. we stood to the southward to reach our fishing-ground at daylight of the following morning. The trawl-line, containing 1,000 hooks, was baited during the night. A school of menhaden was seen outside of Brenton's Reef light-ship, and a swordfish on Cox's Ledge. With these exceptions no surface fish were seen during the day.

Light SW. winds, hazy weather, and smooth sea were experienced on the 2d. At 5.24 a. m. we set the trawl-line in 101 fathoms, green mud and fine sand, latitude 40° 03′ 00″ N., longitude 70° 38′ 00″ W. The boat returned at 9.45 a. m. with 103 hake, 2 whiting, 1 large skate, and 49 dogfish, but no tilefish. The line was set again at 1.25 p. m. in 136 fathoms, green mud and sand, latitude 40° 00″ 15″ N., longitude 70° 55′ 30″ W., the boat returning at 5.40 p. m. with 68 hake, 4 whiting, and 5 large skates. No tilefish were taken. We made three hauls of the trawl during the day on the slope near the fishing-boat, where we found many of the forms discovered by the Fish Hawk in 1880. All fish taken were examined, and numerous parasites found. Some of the whiting had partially-developed roes, and in the numerous dogfish were found recently-impregnated eggs and half-grown embryos. Life on the surface was very meager, a few petrels and one swordfish being all that was seen.

Light SE. to SW. winds prevailed on the 3d with cloudy weather and an occasional shower during the first part. The sea was smooth and everything favorable for our work. At 5.30 a. m. we set the trawl-line in 113 fathoms, green mud and fine sand, latitude 40° 01′ 30″ N., longitude 71° 12′ 30″ W., the catch being 98 hake, 15 whiting, 3 skates, and

1 dogfish. At 2.07 p. m. we set the line again in 237 fathoms, green mud and fine sand, latitude 39° 54′ 30″ N., longitude 71° 08′ 00″ W., the catch being 5 large skates and 1 whiting. We hardly expected to take many fish at the depth in which we set the line, but having tried shoaler water without success, we considered the experiment worth a trial. We were somewhat surprised at the absence of hake on the line, as we were not out of their depth, for we took large numbers of them in the immediate vicinity with the trawl-net. Two hauls of the trawl were made during the day, and a set of serial temperatures and water specimens taken in the evening.

During the early part of the 4th we had light SW. winds, cloudy weather, and occasional showers. It cleared, however, before noon and ended with a brisk breeze from SSW., and clear, pleasant weather. At 4.30 a. m. we sounded and put the trawl over in 600 fathoms, green mud, latitude 39° 49′ 30″ N., longitude 70° 26′ 00″ W. It loaded up so heavily that much time was expended in heaving it to the surface, and then we did not succeed in landing it on board until the bridle-stops parted and relieved the trawl of most of its load. It was a good haul, notwithstanding the loss, several valuable specimens being found in the net. It was lowered again at 10.53 a. m. in 1,180 fathoms, latitude 39° 40′ 00″ N., longitude 70° 20′ 15″ W., but failed to reach the bottom, although more than the usual allowance of rope was given it. Several specimens were taken, however, from intermediate depths, and the contents of the wing-nets possessed more than usual interest, owing to the rapid towing.

The next haul, in 961 fathoms, green mud, latitude 39° 45′ 30″ N., longitude 70° 17′ 00″ W., was an unfortunate one, as the trawl buried in the soft mud so deeply that we were unable to clear it, even after hours of careful manipulation, and were obliged to break the rope. Fortunately it parted near the end, the loss being confined to the trawl itself and the wing-nets. A set of serial temperatures and water specimens were taken during the evening to a depth of 700 fathoms. We were surrounded by the usual number of petrels during the day, and several dolphins were seen about the ship. With the above exceptions no life was seen on the surface. It was our intention to set the trawl-line again, but the sea was rather rough for boat-work, so we decided to pass the time in dredging, which we could carry on in comparative comfort, even with a moderately heavy sea.

At 5.30 a. m. the following morning we lowered the trawl in 1,060 fathoms, latitude 39° 46′ 30″ N., longitude 70° 14′ 45″ W., and made a successful haul. We sent it down again in 1,122 fathoms, latitude 39° 44′ 30″ N., longitude 70° 10′ 30″ W., at 11.20 a. m., and brought up a heavy load of stones with a fair proportion of specimens. At 3.15 p. m. we sounded in 1,140 fathoms, latitude 39° 43′ 45″ N., longitude 70° 07′ 00″ W., and put over the trawl. After landing it on deck at 6.55 p. m., we found the tail folded snugly over the beam, closing the net entirely.

This was the first accident of the kind for nearly two years. There were a few specimens taken in the folds of the net, and the wing-nets brought up their usual collection of minute forms. At 7.13 p. m. we put the trawl over again in 1,058 fathoms, latitude 39° 44′ 00″ N., longitude 70° 03′ 00″ W., and at 11 p. m. landed it on deck after a successful haul. As soon as it was up we steamed to the southward, and at 4.45 a. m. sounded in 1,230 fathoms, latitude 39° 35′ 00″ N., longitude 69° 44′ 00″ W., and put the trawl over, landing it on deck again at 9 a. m. after a successful haul. The southerly swell was still rolling in, but had become more regular, and as the wind had moderated to a gentle breeze, we concluded to set the trawl-line again, and stood to the northward for that purpose.

At 11.30 a. m. we sounded and set the trawl-line in 84 fathoms, sand, gravel, and broken shells, latitude 39° 56′ 30″ N., longitude 69° 43′ 00″ W., the catch being 15 hake and 8 dogfish. Having failed to discern any sign of the presence of tilefish after examining the whole region where they have been taken heretofore, it would, I think, be safe to assume that they have abandoned that locality. Four hauls of the trawl were made while the fishing party was away, in the immediate vicinity of the above position, the material procured being the well-known forms we have dredged from this region in former years. Our bait and alcohol being expended we started for port at 6 p. m. The weather was clear and pleasant, with SW. airs, but at 10 p. m. we ran suddenly into a dense fog-bank, seen ahead for an hour or more, and from that time to our arrival in Wood's Holl, at 1 p. m. on the 7th, we were groping our way through it.

We were employed during the 8th in cleaning ship, overhauling apparatus, &c., and on the 9th hauled fires to clean and repair boilers. A schooner with coal for us arrived early on the morning of the 14th, and we took on board $101\frac{1221}{2240}$ tons during the day.

Preparations for a dredging trip were completed on the 16th, and at 4 p. m. on the 18th we left port and steamed to the southward for about latitude 39° 40′ 00″ N., longitude 71° 35′ 00″ W., where we proposed to commence work at daylight the following morning. The wind was light to moderate from SW., with a smooth sea. At 9 p. m. a thick fog set in, which continued through the night. The usual outlook was kept for surface fish; none were seen, however, except a school of porpoises early in the evening.

At 6.10 a. m. on the 19th we sounded in 538 fathoms, latitude 39° 39′ 45″ N., longitude 71° 35′ 15″ W., and put the trawl over. Four successful hauls were made during the day in the same locality, the depth of water varying from 500 to 700 fathoms. The hauls were particularly rich in the large red crabs (*Geryon quinquedens*) peculiar to this locality, between fifty and sixty being taken. Several being prepared they were eaten by the officers, who were unanimous in the opinion that they were very sweet and palatable. Several species of cephalopods were taken,

besides fish, sea-urchins, starfish of various kinds, and many fine specimens of flabellum. Dead octopods (*Alloposus mollis*) were passed frequently during the day. Gulls were seen flying about the ship, an unusual occurrence with us in this locality, and large numbers of petrels were hovering around us. At 4.18 a. m., August 20, we sounded in 1,073 fathoms, and put the trawl over, latitude 39° 35′ 00″ N., longitude 71° 18′ 45″ W. Three hauls were made during the day, the first two very successful, and the last, although containing a fair number of specimens, was remarkable principally for the enormous load of mud brought up in the net, which must have buried as soon as it struck bottom. It required hours of labor and most careful handling to get it on board. A set of serial temperatures and water specimens were then taken to a depth of 800 fathoms, after which we steamed ahead slowly for an hour, to allow of surface towing. Later in the evening we hove to, and with the assistance of the submarine electric light took a large number of squid and several small surface fish. The hauls during the day were particularly rich in deep-sea fish, holothurians, benthodytes, anthozoa, ophiurans, sea-urchins, &c. A large number of *Geryon* were taken also.

The 21st commenced with moderate SW. winds, smooth sea, and squally, rainy weather, continuing until about 8 a. m., when it cleared. At 5.20 a. m. we sounded in 1,178 fathoms, latitude 39° 33′ 00″ N., longitude 71° 16′ 15″ W., and put the trawl over. Four hauls were made during the day, three of them successful, but the last was very light. The character of the specimens was much the same as those taken on the 20th, with the addition of a brachiopod shell, which is exceedingly rare in this locality.

The weather continued good during the 22d, when five hauls of the trawl were made in the vicinity of latitude 40° 00′ 00″ N., longitude 70° 30′ 00″ W., in from 384 to 963 fathoms. The bottom was composed of a soft and exceedingly tenacious mud, which would not wash through the meshes of the net. The first three hauls were composed principally of this material, the specimens being very few compared with the numbers usually found in the same depths a few miles to the eastward. The last two hauls were better, a number of valuable specimens being taken.

The wind gradually increased during the 23d until at dark we had a brisk breeze and moderate swell, with falling barometer and unsettled weather. The trawl was lowered at 5.37 a. m. in 924 fathoms, latitude 39° 47′ 20″ N., longitude 69° 34″ 15′ W., and brought up an enormous load of mud with a few good specimens. The dredge-rope stranded at a splice while heaving in, 1,380 fathoms from the end, and, in order to repair it with as little delay as possible, the deep-sea dredge was lowered and rope veered until the bad place was reached, when a strand was put in. The dredge, which had been dragging slowly on the bottom, brought up a number of specimens. Four hauls were made during the day, with fair success, and a set of serial temperatures and water specimens was taken in the evening.

The fish taken during the trip represent forty-three species, fifteen of which we were unable to identify. Among those occurring in the largest numbers may be mentioned the *Macrurus Bairdii*, pole-flounders, *Synaphobranchus pinnatus*, *Histiobranchus*, and *Haloporphyrus*. A chowder was made from the last-named fish one day, which was eaten by all the officers and naturalists, the universal opinion being that it was a good chowder, *almost* as good as it would have been *without the fish*. Nearly the same species were taken at each haul, varying somewhat in numbers.

At 10.05 p. m. we started for port. The weather was squally, with occasional showers and lightning from NW. At 3.40 a. m. on the 24th we ran into a thick fog, which lasted till 9.30 a. m., at which time we were near No Man's Land. We arrived in Wood's Holl at meridian and made fast to our moorings.

The specimens taken during the trip were landed the following day, the starboard boiler was blown down for cleaning and repairs, the dredge-rope spliced where it stranded during the trip, and preparations were made for coaling. The weather was squally and rainy during the day.

At meridian August 26th, we left Wood's Holl for Newport, R. I., under the following orders:

U. S. COMMISSION OF FISH AND FISHERIES,
Wood's Holl, Mass., August 26, 1884.

SIR: A telegram just received from the Secretary of the Navy inquires whether he can borrow the steamer Albatross for a week. If the vessel is in a suitable condition to move, or can be readily made so, you will proceed to Newport and report to the Secretary for such duty as he may wish to assign you for the period in question. While in Newport, should you find it expedient to take on board coal for the vessel before returning to Wood's Holl, you will do so. You will also report your arrival at Newport by telegraph, and keep me duly informed of the general movements of the vessel.

Very respectfully,

S. F. BAIRD,
Commissioner.

Capt. Z. L. TANNER,
Commanding Steamer Albatross, Wood's Holl, Mass.

Reported at Newport 5 p. m., August 26, 1884.

WM. E. CHANDLER,
Secretary of the Navy.

The weather was thick and foggy in the Sound, but became more favorable as we approached Newport, where we anchored at 4.50 p. m., and at 5 p. m. I reported for duty to the Secretary at the torpedo station, as indicated by his indorsement on the orders above quoted. He visited the ship at once, accompanied by Capt. Thomas O. Selfridge, U. S. N., commandant of the station, inspected the vessel, her quarters,

&c., made an appointment for the following morning, and at 6 p. m. left the ship, returning to the torpedo station.

The Despatch, flying the flag of the President of the United States, was lying in the inner harbor, and the following vessels of the North Atlantic fleet were at anchor outside of Goat Island: The Tennessee, flying the flag of Acting Rear-Admiral Luce; Swatara, Vandalia, and Alliance. The monitors Passaic and Nantucket, and the torpedo-boat Alarm were at moorings near Coaster's Harbor Island.

At 9.20 a. m. on the 27th the fleet got under way and steamed up Narragansett Bay, anchoring off Conanicut Park to await the arrival of the President and the Secretary of the Navy. At 11.50 the Despatch, flying the flag of the President, steamed up the bay, followed by the Albatross at 11.55, flying the flag of the Secretary of the Navy at the main. We soon joined the fleet and took a favorable position to witness torpedo practice by the several vessels, after which we returned to Newport, anchoring in the inner harbor near the Despatch.

The services of the vessel were not required on the 28th, the day being spent by the President, Secretary of the Navy, officers of the fleet, and invited guests at the torpedo station, witnessing various experiments and inspecting the buildings and workshops. The President was saluted with twenty-one torpedoes when he landed on the island.

At 9.15 a. m., on the 29th, the fleet got under way and proceeded to sea. The Albatross, with the Secretary of the Navy and a distinguished party on board, followed at 10.55 a. m. The iron-clads that had gone out during the morning were met off Beavertail, standing in.

We joined the fleet to the eastward of Point Judith about noon, and witnessed target practice, tactical exercise, and, finally, sail and light-spar drill. The Despatch, flying the President's flag, joined the fleet in time to see the later evolutions and sail exercise. We returned to Newport in company with the fleet, and anchored at 3.45 p. m.

The weather was overcast on the morning of the 30th with light westerly winds. Heavy rain set in about 4 p. m. and continued during the evening. At 9.15 a. m. the fleet got under way and steamed up the bay, anchoring off Coddington Point, where the Despatch, flying the President's flag, and the Albatross, bearing the flag of the Secretary of the Navy, joined them at 12.10 p. m. A landing party was sent on shore from the fleet about 1 p. m. and had a sham battle, was reviewed by the President, and returned on board about 3 p. m., when the fleet returned to its former position outside of Goat Island. At 4.15 p. m. the Despatch and Albatross got under way and steamed around the fleet in company. The yards were manned and a salute of twenty-one guns fired in honor of the President, after which both vessels steamed to the inner harbor and anchored at 4.56 p. m.

The weather was overcast and rainy during the morning of the 31st, clearing at noon. At 2.30 p. m. we got under way for Wood's Holl, having the Secretary of the Navy on board. Soon after 4 p. m. we ran

into a fog, making it necessary to feel our way very carefully. The Vineyard Sound light-ship was sighted at 5 p. m., and taking our departure from it we ran to the vicinity of Tarpaulin Cove and hove to until 7 p. m., when, the fog lifting a little, we saw the light and stood in, anchoring at 7.27 p. m. for the night. The wind veered to NW. soon after, and the weather became clear and pleasant.

At 4.43 a. m. the following morning, September 1, we got under way, arriving in Wood's Holl at 5.20 a. m. The Secretary visited the wreck of the Tallapoosa during the day, and on his return was met by Com. J. G. Walker, Chief of the Bureau of Navigation, and Chief Constructor T. D. Wilson, who came here by direction of the Secretary to confer with him on matters pertaining to their respective Bureaus. The party remained on board during the night, leaving by train on the morning of the 2d, when the Secretary's flag was hauled down and the work of the Commission resumed.

The wire on the working reel was overhauled and splices renewed where they showed signs of wear. Fires were hauled and repairs commenced on the starboard boiler. We coaled ship on the 3d, taking on board $79\frac{2013}{2240}$ tons. Repairs on the boilers were completed on the evening of the 4th, and at 4.20 p. m. on the 5th we cast off from our moorings and started for an offshore dredging trip. Passing No Man's Land at 7 p. m. we laid a course S. $\frac{5}{8}$ W. per compass, intending to reach a depth of about 1,500 fathoms by 9 a. m. the following morning. The night was exceedingly pleasant, with moderate SW. wind, a smooth sea, and the full moon shining brightly in a cloudless sky.

At 9 a. m. on the following morning we sounded in 1,525 fathoms, latitude 39° 05′ 30″ N., longitude 70° 44′ 30″ W., and at 9.57 put the trawl over with wing-nets and mud-bag attached. It was landed on the bottom at 11.34 a. m., with 2,200 fathoms on the dredge-rope, dragged until 12.39 p. m., and landed on deck at 2.13 p. m. after an unusually rich haul. At 2.20 p. m. we sounded again in 1,537 fathoms, latitude 39° 03′ 15″ N., longitude 70° 50′ 45″ W., and at 3.03 p. m. put the trawl over with wing-nets and mud-bag attached, as usual, veering to 2,300 fathoms on the dredge-rope. It was landed on deck at 7.51 after a successful haul, and at 7.53 we started ahead full speed on a southerly course to deepen the water.

Although this report is intended merely to chronicle the movements of the ship and the mechanical operations performed in procuring specimens, leaving the purely scientific data in the hands of the naturalists, it may not be out of place simply to mention some of the principal objects of interest. In our hauls to-day a large quantity of foraminifera was procured, not only in the mud-bag secured to the tail of the trawl-net, but in the trawl itself; particularly in the first haul. Immense numbers of small ophiurans were taken in both hauls, the lower portion of the trawl-net being literally covered with them; several specimens of small brachiopods exceedingly rare in this region

were taken in the first haul, besides three species of starfish, small ascidians, several species of anthozoa, one very large shrimp and numerous smaller ones, a variety of shells, and several benthodytes, the largest we have ever taken. A remarkable feature of the last haul was the bringing up of several bricks with a quantity of mortar. Conjecture was rife as to the origin of our peculiar catch, the classical mind suggesting that we had been raking over the chimneys of famed Atlantis; whereupon the practical man destroyed all romance by the matter-of-fact statement that it was in all probability the discarded try-works of some homeward-bound whaler.

At 4.40 a. m. on the 7th we sounded in 2,516 fathoms, latitude 37° 48′ 30″ N., longitude 69° 43′ 30″ W., and at 6.42 put the trawl over with usual attachments of wing-nets and mud-bag, veering to 3,800 fathoms on the dredge-rope. While the trawl was down a boat was lowered and a large dead octopus secured from the surface. The trawl was landed on deck at 1.20 p. m., but had no bottom specimens; there were, however, several shrimp, one squid, and nine *Cyclothone lusca* in the trawl, besides many small crustaceans in the wing-nets. The current of the Gulf Stream was running between 3 and 4 knots per hour, which, even with every precaution, prevented our landing and retaining the trawl on the bottom. While heaving in, the dredge-rope stranded 1,996 fathoms from the end, and we were obliged to run that amount overboard with a sinker attached, and repair the damage by putting in a new strand. This occupied us until 6 p. m., when we took a set of serial temperatures and water specimens to 1,000 fathoms. A comparison of this series with others taken on opposite sides of the Gulf Stream will show conclusively the depths to which its waters penetrate the ocean bed. The taking of serial temperatures in a 4-knot current is by no means a simple operation, and wholly impracticable with our ordinary methods. It is our custom to use the dredge-rope with a hundred-pound sinker attached for taking serial temperatures and water specimens, but the vibration of the rope was so great in the present instance that it played havoc with the thermometer readings, and obliged us to resort to the sounding-wire. Even then we could use only two thermometers at a time, which made it a slow and tedious operation.

Marine life was more plentiful during the day than usual. A school of finback whales was seen during the forenoon, and occasionally a sea-bird. A school of blackfish passed us about dusk, and a small gray bat, which had been hovering about the ship for a day or two, was captured and kept alive. After dark the submarine electric light was brought into requisition, and by its aid a shark 7 feet 3 inches in length was captured, and five young about 6 inches in length were taken from it. A sucker-fish (*Echeneis remora*) was also captured. It clung tenaciously to the shark until landed on deck, when it was forcibly removed. The larger fish was carefully examined for parasites, without, however, meeting with success.

At 7 a. m. the following morning we sounded in 2,574 fathoms, latitude 36° 16′ 30″ N., longitude 68° 21′ 00″ W., and at 8.31 put over the trawl, with the usual attachments, veering to 3,800 fathoms on the dredge-rope, landing it on the bottom at 11.05 a. m. It dragged until 1 p. m., when we began heaving in, and at 1.24 the rope parted at 3,400 fathoms, under a strain of 5,000 pounds. It broke inboard, and, fortunately, the loose end caught under the guard of the block at the boom end, holding the rope under a tension of over two tons until we could secure it. It was spliced, and the trawl hove up and landed on deck at 7.40 p. m., after a successful haul, although the amount of material was no larger than usual in the same depth. The mud-bag came up full of ooze, rich in foraminifera, and in the trawl were two dozen *Ophioglypha convexa*, several shrimp, shells, one large galacantha-like form, several fragments, and one whole octopus, besides one specimen of *Sternoptyx diaphana*. A variety of minute crustaceans was as usual found in the wing-nets. A set of serial temperatures and water specimens to 1,000 fathoms was taken after the trawl was up. A few sea-birds and a solitary shark were the only evidence of marine life seen during the day. At 9.35 p. m. we started ahead WSW. ¼ W. per compass to change the ground.

At 5.07 a. m. on the 9th we commenced to sound, but the stray-line parted when 600 fathoms had run out, obliging us to reel in the wire and begin again. The sinker and sounding-rod were lost. At 6.07 we got bottom in 2,513 fathoms, latitude 36° 05′ 30″ N., longitude 69° 51′ 45″ W., and at 7 a. m. put the small trawl over, with wing-nets and mud-bag attached, landing it on the bottom at 9.23 with 3,300 fathoms of rope out. The splice in the rope at 3,400 fathoms was renewed while the trawl was dragging. We commenced heaving in at 12.30 p. m., landing the trawl on deck at 3.06 p. m., with an enormous load of clay and a fair collection of specimens. The mud-bag came up full of blue and gray clay with a mixture of ooze, containing a small amount of foraminifera. In the trawl wings we found a few crustaceans, and in the trawl itself was the load of clay above-mentioned, several *Ophioglypha convexa*, a number of large cephalopods in good condition, nearly a bucketful of small stones, several shells, a small piece of wood, and two unknown fish. After the trawl was landed on deck, serial temperatures and water specimens were taken to a depth of 1,000 fathoms, and at 5 p. m. we started ahead WNW. per compass to change our station. After running all night we sounded at 5 a. m. the following morning in 2,045 fathoms, latitude 37° 00′ 00″ N., longitude 71° 54′ 00″ W., and at 6.20 put the small beam-trawl over with wing-nets and mud-bag attached. It landed on the bottom at 8.20 with 3,000 fathoms of rope out, and at 9.58 we began heaving in, landing it on deck at 12.15 p. m. The rope stranded at 2,500 fathoms while heaving in, causing a delay of half an hour repairing it. At 12.20 p. m. we sounded in 2,109 fathoms, latitude 36° 55′ 23″ N., longitude 71° 55′ 00″ W., and at 1.15 put the small trawl over, with attachments as before, landing it on the bottom at 3.25 with 3,200 fathoms of rope

out. After dragging an hour the trawl buried in the mud and clay of the bottom and was lost, together with the wing-nets and mud-bag.

In the first haul several valuable specimens were taken. Among them were three very large red shrimp and many smaller ones, a variety of anthozoa, ophiurans, *Ophioglypha convexa*, several species of starfish, including a rare *Archaster*, shells, &c. A few crustaceans were found in the wing-nets, and the mud-bag was filled with rich foraminiferous ooze. Several varieties of fish were taken, among thém a large number of *Macrurus asper*, a few *Cyclothone lusca*, and a single specimen of *Sternoptyx diaphana*. A set of serial temperatures and water specimens were taken to 1,000 fathoms, and at 9 p. m. we started ahead W. ½ N. per compass for the night. The hauls described above were taken about the center of the Gulf Stream, with a current of 2 knots or more per hour; a condition which would be rather favorable than otherwise in shoal water, but in depths exceeding 2,000 fathoms it complicates matters more than one would believe, unless one had experienced the perplexities of keeping the trawl on the bottom without kinking the rope or burying it so deeply as to lose the outfit.

We left the Stream between 4 and 5 o'clock the following morning, the water changing from 83° to 78° Fahr.; and at 5 a. m. sounded in 1,582 fathoms, latitude 37° 25′ 00″ N., longitude 73° 06′ 00″ W. The trawl was lowered at 5.37, the dredge-rope veered to 1,984 fathoms, and the vessel allowed to drift while a splice was made 2,000 fathoms from the end, where the rope stranded. The trawl was landed on deck at 11.25 a. m., with an enormous load of mud and a variety of valuable specimens. A sounding was then taken in 1,600 fathoms, latitude 37° 22′ 53″ N., longitude 73° 06′ 30″ W., and a set of serial temperatures and water specimens obtained to 1,000 fathoms. We then steamed to the northward and westward until 4.12 p. m., when we sounded in 1,423 fathoms, latitude 37° 38′ 40″ N., longitude 73° 16′ 30″ W., and at 4.54 put the trawl over, landing it on the bottom at 6.10 p. m., with 2,100 fathoms on the dredge-rope. It dragged until 7.05 and was landed on deck at 8.35, proving an excellent haul. At 9.30 p. m. we started ahead NNE. per compass to change our station.

Among the many valuable specimens taken during the day may be mentioned a variety of anthozoa, large quantities of foraminifera, several specimens of benthodytes, large quantities of *Archaster grandis*, and other varieties of starfish, shells, worm-tubes, some very small holothurians, and a heavy load of a substance which resembled cinders from a furnace, both in color and form, but there the resemblance ceased. It was light and quite soft, crumbling under pressure of the hand, and cutting readily with a knife. It came up in fragments from the size of a silver dollar to a foot in diameter, and from ½ inch to 1½ inches in thickness. There were many burrows, or worm holes, running through the mass, some of them three-eighths of an inch or more in diameter. From appearances I should judge that this peculiar sub-

stance formed a crust underlying a thin covering of ooze through which it frequently cropped out, as many of the fragments were covered with anthozoa, shells, and worm-tubes. The mud-bag, which is simply a boat-dredge with a tight canvas bag attached to the end of the trawl-net, was filled with soft foraminiferous ooze, but there was none of the substance referred to above, indicating that it had simply skimmed along the surface without penetrating the dense medium below. There were not many fish taken; a few *Macrurus asper*, *Haloporphyrus viola*, and *Licodes* being the most important.

At 4.37 a. m. on the 12th we sounded in 1,168 fathoms, latitude 38° 27′ 00″ N., longitude 73° 02′ 00″ W., and at 5.17 put the trawl over, veering to 1,800 fathoms on the dredge-rope. It was landed on deck again at 8.33 a. m. Three more hauls were made during the day, all of them fairly successful. Enormous loads of mud were brought up, rendering the work of hoisting rather tedious, but it served the purpose of protecting delicate specimens, the result being that our catch was as a rule in excellent condition. The result of the day's work may be summarized as follows: ooze, mud, and clay from the trawl-net, mud-bag, and on one occasion even the wing-nets gave us many minute shells, foraminifera, and worms. Several specimens of *Octopus Bairdii* were taken in good condition. *Benthodytes* were plentiful, and *Geryon quinquedens* were found in large numbers in some of the hauls. Shrimp, worms, shells, starfish, and ophiurans were more or less abundant. Two species of *Archaster* were taken. As we were operating in comparatively shallow water the number and variety of fish was notably increased. *Haloporphyrus viola* were found in considerable numbers, and a few specimens of *Macrurus asper*, *Halosaurus macrochir*, *Chauliodus Sloani*, and *Macrurus Bairdii* were taken. *Phycis Chesteri*, whiting, small skates, and pole-flounders were more plentiful, while single specimens only were found of *Halieutæa senticosa*, *Alepocephalus*, the snipe, and long-nosed eels, &c. Three unknown species were taken. Serial temperatures and water specimens were taken in the evening, after which we steamed to the northward and eastward to change our working ground.

The weather, which had been exceptionally pleasant during the trip, became squally and unsettled in the morning, with brisk winds from NE., moderating, however, toward evening. We were visited during the day by several small land-birds, a fish-hawk, a couple of small bats; schools of porpoises and blackfish were seen also. Attempts were made to capture a porpoise, but they kept out of reach of our harpoons.

At 4.30 a. m. on the 13th we commenced work in 810 fathoms, latitude 39° 09′ 00″ N., longitude 72° 13′ 15″ W., making five hauls during the day. All of them were successful except the last, when the net came up empty, the lashing having parted. Large numbers of *Geryon quinquedens*, large soft sea-urchins, shells, shrimps, *Flabellum Goodeii*, and starfish were taken; also a large quantity of foraminifera and

crustacea. The collection of fish was quite extensive and interesting, although well-known, a single specimen only remaining unrecognized. The list of species taken the previous day, with the addition of a dogfish, *Synaphobranchus*, *Chimæra*, *Stomias ferox*, *Cottunculus torvus*, a pug-nosed eel, and a black dogfish would represent our catch during the day. In addition to the above, we caught a dolphin (*Coryphæna*) with a hook and line, and a shark (*Aprionodon punctatus*) seven feet seven inches in length. A single specimen of sucker (*Echeneis remora*) was taken from the shark's side and preserved in alcohol. The larger fish was examined for parasites, several being found. Serial temperatures and water specimens to 700 fathoms were taken after we finished dredging, and at 7.52 p. m. we started for port.

The wind increased gradually during the day, until at dark it was blowing a moderate gale from NE. with a heavy swell. This continued during the night, moderating the following morning as we approached land. We reached Wood's Holl at 4.20 p. m. on the 14th without incident worthy of notice, and made fast to our moorings.

We were employed during the 15th in landing specimens and overhauling apparatus. Fires were hauled and preparations made for cleaning and repairing the boilers. Hon. Theodore Lyman, M. C., and Sir Lyon Playfair, M. P., visited and inspected the ship and her scientific apparatus during the day.

We coaled ship on the 18th and 19th, taking on board 99¾ tons. The boilers were ready for service on the evening of the 20th, and fires were started on the 22d, with the intention of going to sea, but unfavorable weather being reported by the Chief Signal Officer, we remained in port until 8.05 a. m. on the 25th. We then left for Newport to procure bait, with which we proposed to try for fish in the various localities where our dredging and trawling operations would carry us. Our work was to be confined to depths between 30 and 125 fathoms, for the purpose of ascertaining at what point the Gulf Stream waters cease to exert a perceptible influence on the fauna at the sea-bottom.

Mr. Richard Rathbun, Sanderson Smith, Peter Parker, jr., and Willard Nye, jr., accompanied us as naturalists, in addition to Mr. James E. Benedict, the resident naturalist.

We arrived at Newport at 1 p. m., procured three barrels of fresh menhaden for bait, and at 2.30 p. m. left the harbor and stood to the southward. Reaching Cox's Ledge at 5.30 we hove to and tried for codfish, but failed to take a single specimen, although we kept lines over for three hours. A dogfish was taken from the bottom and a rare species of shark from the surface, the latter having been attracted to the ship's side by the submarine electric light, which was being used to catch squid. Two schools of small mackerel were seen while we were hove to on the ledge. At 8.30 p. m. we started ahead slowly, and surface towing was carried on till 9.30, when we laid a course SSE. for the night. Fresh breezes from SSW. prevailed during the morning

with clear sky, the wind moderating about noon, and at 9 p. m. it veered to NE., with overcast, rainy weather.

At 5.25 a. m. on the 26th we put the trawl over in 32 fathoms, latitude 40° 38′ 00″ N., longitude 70° 29′ 45″ W. Eight hauls were made during the day in a southerly direction, ending in 122 fathoms, latitude 39° 56′ 45″ N., longitude 70° 20′ 30″ W. The hauls were all successful; large numbers of pectens were taken, particularly at station 2241, when over 500 were found in the net, besides shells of various species. Worms, among which were *Lætmatonice armata* and *Hyalinœcia artifex*, were plentiful, as well as *Archaster americanus* and *Ophioglypha Sarsii* among the echinoderms. Shrimp, crabs of various species, and mollusks were found in every haul. The fish were represented by seventeen species, *Phycis chuss* being the most plentiful. One hundred and seventy squid were taken during the evening with jigs, the submarine light being used to attract them alongside. A large mackerel-shark was caught with hook and line. Strong winds prevailed during the day, with a heavy swell, making boat service impracticable; even the dredging operations were carried on with some inconvenience at times.

Work was resumed at 5 o'clock the following morning, the trawl being lowered in 78 fathoms, latitude 40° 03′ 00″ N., longitude 69° 57′ 00″ W. Eight hauls were made during the day in a northerly direction between the above position and latitude 40° 46′ 30″ N., longitude 69° 50′ 15″ W., in 18 fathoms. From dark until 8.20 p. m. hand-lines were used and a large number of dogfish taken. Earlier in the evening we hove to in 25 fathoms and tried for codfish, but met with no success. Two porpoises were taken with the harpoon and iced, and a fish-hawk was shot and the skin preserved. The catch during the first part of the day was much the same as yesterday, but the bottom changed later and we brought up great numbers of sand-dollars, filling the table-sieve at a single haul. Fifteen species of fish were taken, *Glyptocephalus cynoglossus* being plentiful and of large size; the first full-sized specimens we have taken south and west of Monomoy Point. The weather was more moderate during the day and toward evening the sea became quite smooth, but the barometer was falling steadily and the weather indications were decidedly unfavorable.

At 5.32 a. m. on the 28th we put the trawl over in 30 fathoms, latitude 40° 38′ 30″ N., longitude 69° 29′ 00″ W., and ran a line to the southward, making six hauls between the above position and latitude 39° 54′ 45″ N., longitude 69° 29′ 45″ W., in 250 fathoms. At 4.25 p. m. we started for port, our supply of alcohol being exhausted. During the morning large numbers of sand-dollars and shells were taken, and several very large and perfect specimens of *Asterias vulgaris* were preserved in alcohol. The last haul brought up the table-sieve full of worm-tubes, most of them having sea-anemones attached, besides a few brachiopods.

There were fifteen species of fish taken, corresponding generally with

the list of previous days; *Macrurus Bairdii*, *Macrurus carminatus*, and *Scopelus*, which were taken in the last haul in 250 fathoms, may, however, be added. The weather was unsettled during the evening, and after midnight we had several heavy rain-squalls; the wind moderated, however, as we approached the land.

At 6.30 a. m. on the 29th we arrived in Wood's Holl and made fast to our moorings. The specimens were landed during the day. Slight repairs were made to the machinery and boilers, and on October 7 we received $48\frac{1343}{2240}$ tons of coal on board. All preparations having been made to leave the station for the season, we started for New York at 9.10 a. m., October 8. We stood first for Cox's Ledge and spent several hours trying for fish, with indifferent success. Arriving in New York at 10.30 a. m. the following day, we anchored off Twenty-fourth street, North River. Official visits were received from the U. S. S. Minnesota and the French flagship Flore. The yacht Coquette was capsized near this vessel during a squall. Her crew was rescued and the yacht towed ashore by our steam-cutter.

I returned the official visits from the U. S. S. Minnesota and the French flagship Flore on the 10th, and on the following day the executive officer of the Flore with his aide visited the ship and made an extended and careful examination of vessel and apparatus. Capt. T. H. Parfait was in command of the Talisman during her scientific explorations in 1883. Later in the day, Hon. William E. Chandler, Secretary of the Navy, and Senator Rollins visited the ship. On the 13th, a large party of officers from the Flore came on board and made a thorough examination of the scientific apparatus.

Our stores were all on board and everything ready for sea on the morning of the 16th, but cautionary signals being reported on the coast of North Carolina, we remained at anchor until 10.50 a. m. on the 17th, when we got under way and proceeded to sea.

The wind being favorable, we stood to the southward under steam and sail during the night, and, at 1.30 p. m. the following day, put the trawl over in 430 fathoms, latitude 37° 08′ 00″ N., longitude 74° 33′ 00″ W. Three hauls were made during the afternoon, with good results. At 5.05 p. m. we started again for Hatteras, intending to reach our working ground at daylight the following morning. At 6.15 a. m. on the 19th we put the small beam-trawl over in 111 fathoms, latitude 35° 07′ 00″ N., longitude 75° 08′ 30″ W. It was a very light haul, but the next one in 68 fathoms, within a mile of the former position, was exceedingly rich. Several rare and beautiful starfish, sea-urchins, coral, &c., were found in the remnants of the net, which had been torn by dragging over a bed of coral. The tangles were then used with good results outside of 50 fathoms; and finally a line of dredgings, in which the trawl, with mud-bag attached, was used, was run inshore to 11 fathoms, latitude 35° 21′ 30″ N., longitude 75° 25′ 00″ W. Twenty hauls were made

during the day, nearly all of them bringing up a variety of specimens. Large numbers of crabs, sponges, worms, corals, and fish were taken. Many of the latter we were unable to identify. A large number of minute shells were brought up in the mud-bag. We stood off shore a few miles after the last haul and lay to for the night, keeping within range of the light. At daylight the following morning we ran into 7 fathoms, latitude 35° 22′ 30″ N., longitude 75° 26′ 00″ W., and commenced work, running a line of fourteen hauls offshore, the last one being 671 fathoms, latitude 35° 41′ 30″ N., longitude 74° 48′ 30″ W. Crabs were found very abundant, and worms, sea-anemones, hermit-crabs, &c., were taken in large numbers. A single specimen of a full-grown lobster (*Homarus americanus*) was taken in 49 fathoms. It would be difficult to tell which was the most surprised, the lobster or ourselves, as it is the first time on record of a lobster having been found in these regions. Fish were taken in considerable numbers, and many minute shells were found in the mud-bag.

At 6 a. m. on the 21st we put the tangles over in 57 fathoms, latitude 35° 11′ 30″ N., longitude 75° 05′ 00″ W., in search of the coral bed over which we had dragged the trawl on the previous day, and although we were unable to find the spot, we succeeded in obtaining a number of interesting specimens. Ten hauls with tangles and trawl were made during the day, with fair success; although much time was consumed in an attempt to make a haul with the trawl in the current of the Gulf Stream, which was running nearly four knots an hour.

From 1.10 to 2.35 p. m. we were experimenting with Read's photometer for determining the penetration of light in sea-water. A series of three photographs were taken at 5 fathoms, and another at 25 fathoms; the exposures being 5, 10, and 15 minutes for each depth. The apparatus performed its work satisfactorily at the depths indicated, but it will require some alterations to make it practicable in great depths, where it must necessarily be used.

At 7.56 p. m we started for Washington, D. C., anchoring near Upper Cedar Point at 5.30 p. m. on the 22d, and arriving at the navy-yard at 10.30 a. m on the 23d.

The specimens taken during the trip and other articles consigned to the Smithsonian Institution were landed, and the work of overhauling and refitting commenced. The holds and store-rooms were broken out, cleaned, and restowed; the bilges were cleaned, chains overhauled, the ship painted inside and out, rigging overhauled, &c.

The dredge-rope was examined and an additional quantity reeled on the drum. New trawls and dredges were procured, and a new accumulator of greater length and larger buffers, was substituted for the old one.

Ensign L. M. Garrett reported for duty November 1, and Ensign Franklin Swift on the 1st of December. The weather became very cold

toward the latter part of the month, ice forming around the ship on the 20th thick enough to bear the weight of a man. The vessel was not quite ready for sea, but fearing an ice blockade, we left on the 24th for Norfolk, Va., where we could complete our outfit and sail at any time without fear of detention.

The Eastern Branch was covered with about 3 inches of ice through which we were obliged to break our way until reaching the Potomac, where the channel was kept open by the frequent passage of vessels. Arriving off Quantico about dark we anchored for the night, and getting under way at daylight the following morning, reached Hampton Roads at 9.15 p. m. and anchored near the fort.

A thick snow storm set in during the night, and when we got under way the following morning we could not see more than two or three ship-lengths. We felt our way through it, however, reaching the navy-yard at Norfolk, Va., about 9.30 a. m.

The bunkers were filled with coal, and on the evening of December 31st the Albatross was ready for sea, waiting only the arrival of the naturalists who were to join us for a cruise in the Gulf of Mexico.

The following officers were attached to the ship at this date:

Z. L. Tanner, lieutenant-commander, U. S. N., commanding.

Seaton Schroeder, lieutenant, U. S. N., executive officer and navigator.

A. C. Baker, lieutenant, U. S. N.

C. J. Boush, lieutenant (junior grade), U. S. N.

R. H. Miner, ensign, U. S. N.

L. M. Garrett, ensign, U. S. N.

Franklin Swift, ensign, U. S. N.

J. M. Flint, surgeon, U. S. N.

C. D. Mansfield, paymaster, U. S. N.

George W. Baird, passed assistant engineer, U. S. N., in charge of machinery.

Petty officers.—S. M. McAvoy, John Hawkins, John Bergesen, Walter Blundell, machinists; Charles Wright, master-at-arms; Samuel LeRoy Pritchard, equipment yeoman; N. B. Miller, apothecary; George A. Miller, paymaster's yeoman; Frank L. Stailey, engineer's yeoman.

The crew numbered 59 men.

Mr. James E. Benedict was still attached to the ship as naturalist.

Attention is called to the following appended reports, giving much valuable information in regard to the work of the various departments: Navigation Report; Engineer's Report; Medical Department, Sanitary Report, and Records of Specific Gravities; Naturalist's Report, with lists of birds, fishes, &c., taken; Dredging and Trawling Record; and Table of Serial Temperatures.

NAVIGATION REPORT OF LIEUT. SEATON SCHROEDER, U. S. N., NAVIGATOR.

During the year 1884 the geographical limits of the cruising of the Albatross were the parallels of 8° 30′ and 43° north latitude, and the meridians of 61° 30′ and 85° 30′ west longitude. The number of days at sea and the distances run, together with the object of each trip, are given in the following table:

Date.	Object.	Distance.
		Miles.
January 6 to 7	Baltimore to Norfolk	163
January 10 to 17	Sounding trip	1,417.5
January 24 to 30	Sounding and dredging trip	660.2
February 2	Swinging ship	20
February 3 to 11	Sounding and dredging trip	1,209.4
February 18 to 26	do	1,100.8
February 27 to March 1	do	333.8
March 12 to 16	do	605.1
March 22 to 26	do	429.4
April 2 to 5	do	253
April 9 to 15	do	813.1
April 29	Key West to Havana, Cuba	100
April 30 to May 7	Sounding and dredging trip	603.8
May 11 to 17	Sounding trip	1,279.5
July 13 to 14	Washington to Norfolk	174
July 20 to 26	Investigating migrations of menhaden and mackerel	651.7
July 31 to August 8	Dredging trip	486.4
August 19 to 25	do	429.2
August 27	Wood's Holl to Newport	42
August 28 to 31	Flagship of Honorable Secretary of the Navy	47
September 1	Newport to Wood's Holl	42
September 6 to 15	Dredging trip	943
September 25 to 29	do	424.1
October 8 to 9	Wood's Holl to New York	189
October 17 to 23	Dredging trip	797
December 25 to 26	Washington to Norfolk	174
Total (134 days)		13,388

The number of soundings taken during the year was 701, almost all of which were located with sufficient accuracy to be of hydrographic value; of these, 194 were also dredging stations.

During the winter and spring the vessel was employed in hydrographic work for the Navy Department; searching for reported dangers in the West Indies and between there and the Chesapeake; running lines of soundings across the Caribbean Sea and among some of the islands; taking serial temperatures and noting surface currents; making an examination of a part of Savanilla Bay, United States of Colombia, and establishing the longitude of Cape San Antonio light-house, Cuba.

Following is a list of reported dangers over or near which the depths were found in the positions given:

List of reported dangers.

Name.	Latitude N.			Longitude W.			Depth.
	°	′	″	°	′	″	*Fathoms.*
Orion Shoal	34	48	45	72	25	00	2,462
Ashton Shoal	33	50	20	71	42	00	2,953
Perseveranza Shoal	31	15	42	67	39	10	2,787
Mourand Shoal	24	35	14	65	13	07	3,006
Leighton Rock	17	39	30	73	22	15	2,490
Loos Shoal	17	48	00	73	34	15	2,369
Breakers	12	54	40	66	11	10	2,768
Vigia	12	10	30	66	11	00	2,707
Georgia Shoal	Many soundings.						(Least) 17
Tribune Shoal	12	11	30	74	27	30	2,057
Powhatan Shoal	11	11	00	75	50	30	1,195
Doubtful	14	53	40	80	20	00	1,151
Sancho Pardo Shoal	Off Cape San Antonio.						Many.
Albatross Shoal	22	49	20	84	15	00	950
Vigia	23	06	00	83	03	45	625
Huntley Shoal	30	46	00	78	35	00	470

The soundings were such as to prove the non-existence of all except the Georgia Bank off the east end of Jamaica, which had been recently searched for by several vessels. It was originally discovered by Capt. John S. Holt, of the American brig Georgia, in 1867, who reported 14 fathoms in about latitude 17° 46′ N., longitude 75° 45′ W. An extensive and careful search was made for this, resulting in the discovery of a bank with a least depth of 17 fathoms a little to the southward of the reported position, in latitude 17° 36′ to 17° 44′ N., longitude 75° 40′ to 75° 45′ W. The Navy Department has given it the name of Albatross Bank. This must not be confounded with the Albatross Shoal off the northwestern shore of Cuba, which was reported by the German gunboat of that name, and not subsequently found.

One hundred soundings were taken off Cape San Antonio, extending to just beyond the range of the light, with deep water everywhere (up to 1,200 fathoms), and Sancho Pardo Shoal has, in consequence, been expunged from the charts of the Hydrographic Office, Navy Department.

Six lines of soundings were run across the Caribbean Sea, four between the Leeward Islands and the Main, and diagonal lines on and off the coast of the United States of Colombia. The eastern part of the Caribbean Sea is the deepest, the greatest depth being 2,844 fathoms, in latitude 13° 25′ N., longitude 66° 25′ W. Off the Honduras coast, however, still deeper water was found, there being 3,169 fathoms at 60 miles southwest of the Grand Cayman.

An interesting discovery was that of a submarine ridge connecting the islands of Santa Cruz and Puerto Rico, the least depth on which was 578 fathoms and the greatest 900, while on either side was found over 2,000 fathoms.

Aves Islet, 100 miles westward of Guadaloupe, was found to be the summit of a mountain, precipitous on its western slope and extending in a south-southeast direction over 150 miles to the 1,000-fathom curve.

The longitude of Cape San Antonio light-house (west end of Cuba) was found to be 84° 57′ 38″ W., depending on that of the Soldiers' Monument, Key West, Fla., being 81° 48′ 25″ W. The time was carried to and back by five chronometers, and the observations were of equal altitudes of the sun by sextant and artificial horizon.

The following table gives the position and depth of each sounding while the ship was working for the Navy Department, together with remarks on currents, &c. The numbers above 2,000 indicate dredging stations:

Table of sounding and dredging stations occupied during the winter and spring.

Date.	Number.	Depth.	Bottom.	Latitude N. ° ′ ″	Longitude W. ° ′ ″	Remarks.
		Fathoms.				
Jan. 11	Hyd. 36	2,953	lt. choc. Oz	33 50 20	71 42 00	Near Ashton Shoal.
13	Hyd. 37	2,787	lt. choc. Oz. Glob	31 15 42	67 39 10	Near Perseveranza Shoal.
14	Hyd. 38	2,957	lt. choc. Oz. Glob	28 17 07	66 17 37	
15	Hyd. 39	3,006	stf. choc. C	24 35 14	65 13 07	Near Mourand Shoal.
17	Hpd. 40	3,468	Glob. Oz	19 15 00	65 07 00	
17	Hyd. 41	1,902		18 59 00	65 07 00	Parted wire at 10 fathoms. Light westerly current.
24	Hyd. 42	516	Co. R	18 09 00	64 58 50	Saint Thomas light NNE ¼ E. (mag.). Sail rock NW. ¾ N. (mag.). Slight SW. set.
24	Hyd. 43	1,146	Co. S. For	18 04 30	65 01 10	Sail rock N. by W. ¾ W. (mag.).
24	Hyd. 44	1,975		18 00 00	65 04 00	Wire parted.
24	Hyd. 45	2,501	Co. S. For	17 55 30	65 06 00	Slight SW. set.
24	Hyd. 46	2,423	fne. Co. S. For	17 51 00	65 08 05	Fresh NE. breeze.
25	Hyd. 47	1,482	crs. Co. S. brk. Sh. For	17 46 30	65 10 25	About 1 knot WSW. current.
25	Hyd. 48	978	Co. Oz. For	17 42 00	65 12 40	Do.
25	Hyd. 49	928	Oz. For	17 37 30	65 15 00	Do.
25	Hyd. 50	949	Co. S. For	17 33 00	65 17 20	Moderated to fresh ENE. breeze.
25	Hyd. 51	1,265	Co. Oz. lge. Pter. Sh. For	17 28 30	65 19 40	
25	Hyd. 52	1,895	Co. S. For	17 24 00	65 22 00	Westerly current, about 1 knot.
25	Hyd. 53	1,356	Oz. For	17 29 10	65 23 30	Do.
25	Hyd. 54	990	Co. S. For	17 34 20	65 25 00	Do.
25	Hyd. 55	933	Pter. Co S. For	17 39 30	65 26 30	Do.
25	Hyd. 56	1,243	Pter. Co. Oz. For	17 44 15	65 27 50	
25	Hyd. 57	2,188	Oz. For	17 49 06	65 29 00	Fresh ENE. to NE. breeze.
25	Hyd. 58	1,345	Oz. For	17 45 20	65 35 35	WSW. current, about ½ knot.
25	Hyd. 59	789	Oz. For	17 42 10	65 39 40	Do.
25	Hyd. 60	578	Co. S. For	17 39 00	65 44 00	Do.
25	Hyd. 61	1,303	fne. Co. S. For	17 35 50	65 48 10	Fresh ENE. breeze.
25	Hyd. 62	2,017	Pter. Co. S. For	17 32 40	65 52 20	
26	Hyd. 63	2,690	Co. S. Sh	17 15 30	65 36 20	WSW. current, about 1½ knots, with fresh ENE. breeze
26	Hyd. 64	2,543	fne. Co. S. Sh	16 52 00	65 19 20	Do.
26	Hyd. 65	2,312	fne. Co. S. Sh. For	16 42 02	65 02 20	WSW. current, about 1 knot.
26	Hyd. 66	2,192	Co. S. For	16 28 00	64 42 30	Breeze moderating.
26	Hyd. 67	2,069	Co. S. For. Sh	16 13 45	64 22 30	Very slight W. set, the wind being light from E.
27	Hyd. 68	1,920	yl. Oz. For	16 04 15	64 07 00	Do
27	Hyd. 69	1,060	Co S. For	15 54 46	63 52 00	No appreciable current.
27	Hyd. 70	1,091	Co S. For	15 48 00	63 45 20	
27	Hyd. 71	950	brk. Co. Sh	15 44 10	63 42 10	
27	Hyd. 72	808	fne. Co. S. Sh	15 41 00	63 42 00	House on Aves Islet E. (mag.) 4¾ m.
27	Hyd. 73	355	Co brk. Sh	15 40 18	63 38 36	House on Aves Islet NE. by E. (mag.) 1.3 m.
27	Hyd. 74	15	Co	15 38 32	63 37 36	No appreciable current.
27	Hyd. 75	172	fne. Co. S	15 33 55	63 35 38	
27	Hyd. 76	367	fne. Co. S	15 29 18	63 33 40	
27	2117	683	yl. M. fne. S	15 24 40	63 31 40	

Table of sounding and dredging stations occupied during the winter and spring—Continued.

Date.		Number.	Depth.	Bottom.	Latitude N.			Longitude W.			Remarks.
			Fathoms.		°	′	″	°	′	″	
Jan.	27	Hyd. 77	776	Co. S. For	15	08	20	63	26	00	Light W. set.
	27	Hyd. 78	871	fne. Co. S. Sh	14	44	25	63	18	00	Do.
	27	Hyd. 79	821	Co. S. Sh. For	14	20	30	63	10	00	
	28	Hyd. 80	684	gy. M. For	13	56	35	63	02	00	
	28	2118	690	gy. M. bk. S	13	32	40	62	54	00	
	28	Hyd. 81	815	M. For	13	34	35	62	51	20	
	28	Hyd. 82	1,051	For. M. bk. Sp	13	29	00	62	42	40	
	28	Hyd. 83	1,686	For. M. bk. Sp	13	23	00	62	34	15	
	28	Hyd. 84	1,640	For. M. bk. Sp	13	15	00	62	39	00	
	28	Hyd. 85	1,634	For. M. bk. Sp	13	07	10	62	43	40	No current at all; wind very light.
	28	Hyd. 86	1,635	bu. M. For. bk. Sp	12	58	40	62	48	00	
	29	Hyd. 87	1,642	M. bk. Sp. For	12	50	40	62	53	00	
	29	Hyd. 88	1,630	M. bk. Sp. For	12	29	00	62	38	30	Very slight set to about SSE.; wind light from ENE.
	29	Hyd. 89	1,552	bu. M. For	12	07	30	62	24	00	
	29	Hyd. 90	1,437	bu. M	12	03	00	62	22	20	
	29	Hyd. 91	1,121	gy. bu. M	11	58	00	62	20	50	
	29	Hyd. 92	1,247	gy. M	11	53	19	62	19	10	
	29	2119	1,140	gy. M	11	48	30	62	17	30	Light W. set; ENE. breeze.
	29	Hyd. 93	828	hrd	11	42	40	62	17	00	Do.
	29	Hyd. 94	441	gy. M. fne. S	11	34	20	62	15	40	WNW. current, about 1 to 1½ knots.
	29	Hyd. 95	280	bk. M	11	27	00	62	13	00	
	29	Hyd. 96	70½	crs. G. brk. Sh	11	19	40	62	10	00	WNW. current, about 2 knots, with moderate to fresh ENE. breeze.
	30	Hyd. 97	63	dk. M. crs. S	11	12	20	62	07	10	Do.
	30	Hyd. 98	83	bu. M	11	05	00	62	04	30	2 to 2½ knot WNW. current.
	30	2120	73	bu. M	11	07	00	62	14	30	
	30	Hyd. 99	150	M. S	10	44	45	61	48	18	S. end Chacachacare Island SSE. ⅜ E. (mag.). Cariaquita Point SW. ⅛ W. (mag.).
	30	Hyd. 100	141	bu. M	10	43	45	61	48	50	E. end Goose Island SSW. (mag.). E. end Islette WNW. (mag.).
Feb.	3	2121	31	dk. slat. M	10	37	40	61	42	40	S. side Goose Island W. (mag.). W. end Mono Island N. ¼ E. (mag.).
	3	2122	34	dk. slat. M	10	37	00	61	44	22	S. side Goose Island W. ½ N. (mag.). W. end Mono Island NNE. ½ E. (mag.).
	3	*2123	117	bu. M	10	42	02	61	48	48	E. end Islette NW (mag.). E. end Goose Island SSW. ¾ W. (mag.)
	3	Hyd. 101	61	sft. bu. M	10	54	00	61	58	40	2-knot NW. current; moderate breeze from NNE.
	3	Hyd. 102	57	sft. bu. M	11	02	30	62	06	00	Do.
	3	Hyd. 103	46	brk. Sh	11	19	00	62	22	00	Current about WNW., 1½ knots.
	3	Hyd. 104	178	bu. M	11	34	20	62	38	15	
	3	Hyd. 105	387	bu. M	11	45	30	63	01	00	
	3	Hyd. 106	919	rky	11	59	00	63	27	40	WNW. current, 1 to 1¼ knots; moderate NE. breeze.
	4	Hyd. 107	1,256	gy. M. fne. S	12	09	00	63	57	20	Do.
	4	Hyd. 108	2,020		12	17	30	64	14	30	Wire parted.
	4	Hyd. 109	2,371	gy. Oz	12	22	50	64	38	00	1¼-knot W. current.
	4	Hyd. 110	1,828	br. gy. M	12	41	00	64	23	00	
	4	Hyd. 111	1,714	gy. M	12	59	20	64	08	00	Light W. set; moderate NE. breeze.
	4	Hyd. 112	1,463	br. Oz. For	13	15	30	63	52	10	½ to ¾ knot SW. current.
	5	Hyd. 113	680	gy. Oz. For	13	32	00	63	36	30	Do.

5	Hyd. 114	652	br. Oz. bk. Sp	13	48	50	63	20	00	Do.
5	Hyd. 115	852	yl. M. fne. S	14	07	10	63	37	55	Do.
5	Hyd. 116	1,615	gy. M. For	14	21	44	63	58	45	Moderate NE. breeze; current to SW., about 1 knot.
5	Hyd. 117	1,843	gy. M. For	14	35	10	64	21	10	Do.
5	Hyd. 118	2,115	For. Oz	14	51	00	64	42	00	Do.
6	Hyd. 119	2,461	lt. gy. M. For	15	26	00	65	19	20	
6	Hyd. 120	2,492	gy. M. For	16	01	00	65	56	20	Current to WSW., about ½ knot.
6	Hyd. 121	2,501	choc. Glob. Oz	16	36	20	66	41	00	Breeze falling light, ENE.
7	Hyd. 122	2,458	choc. Oz. For	16	35	20	68	00	30	Light easterly airs. No perceptible current in sounding.
7	Hyd. 123	2,616	choc. Oz. For	15	49	00	67	36	40	Slight set to SSW.; moderate ENE. breeze.
7	Hyd. 124	2,747	choc. Oz. For	15	02	00	67	13	30	Slight set to SW.; light ENE. breeze.
8	Hyd. 125	2,804	choc. M. Co	14	20	30	66	54	00	Slight set to WSW.; light ENE. breeze.
8	Hyd. 126	2,814	br. M. Co	13	40	00	66	35	00	½ to 1 knot WNW. current; ENE. breeze.
8	Hyd. 127	2,844	br. M. Co	13	25	04	66	25	00	1-knot WNW. current; light ENE. airs.
8	Hyd. 128	2,768	dk. choc. Oz	12	54	40	66	11	10	1½ to 2 knot WNW. current; light-ENE. airs.
8	Hyd. 129	2,820	dk. clayey Oz	12	35	20	66	14	00	2-knot WNW. current; light ENE. airs.
9	Hyd. 130	2,707	dk. clayey Oz	12	10	30	66	11	00	2 to 2½ knot NW. current; light ENE. airs.
9	Hyd. 131	1,806	choc. Oz. For	12	04	00	66	16	40	2 to 2½ knot NW. current; light ENE. airs. El Roque light on horizon from a height of 25 feet. Bearing WNW. ½ W. (mag.).
9	Hyd. 132	774	gy. S. brk. Sh	11	49	00	66	16	50	Astronomical position; Orchilla Island distant 6 miles; principal peak E. ½ N. (mag.). No current.
9	Hyd. 133	533	gy. M. For	11	33	20	66	19	00	½ to ¾ knot W. current; ENE. breeze.
9	Hyd. 134	656		11	18	50	66	24	20	½ to ¾ knot W. current; ENE. breeze. Stray line parted (35-pound lead).
9	Hyd. 135	239	gn. M. S	11	05	00	66	39	00	¾-knot W. by S. current; breeze ENE.
9	Hyd. 136	150	bu. M. fne. S	10	51	00	66	35	00	Do.
9	Hyd. 137	135	gn. M. fne. S	10	42	30	66	48	20	Line of bearing of sun, and bearing and distance of Punta Anare.
9	Hyd. 138	164	gy. S. brk. Sh	10	51	30	67	01	40	About ¾ to 1 knot current to WSW.
9	Hyd. 139	605	gy. M	11	01	00	67	14	15	Do.
9	Hyd. 140	917	gy. M	11	09	40	67	27	00	Do.
10	Hyd. 141	1,040	lt. choc. M	11	19	50	67	40	00	Do.
10	Hyd. 142	1,021	gy. M	11	28	10	67	53	00	Do.
10	Hyd. 143	1,030	lt. gy. C	11	37	30	68	06	30	½ to ¾ knot westerly current.
10	Hyd. 144	980	gy. M	11	46	40	68	19	50	½-knot westerly current.
10	Hyd. 145	630	wh. S. R	11	52	00	68	35	40	Do.
10	Hyd. 146	641	yl. M. fne. S	11	55	20	68	46	00	½-knot W. by N. current; positions checked by bearing and distance of Little Curaçao light plotted in latitude 11° 58′, longitude 68° 39′.
10	Hyd. 147	507	gy. M	11	59	00	68	49	00	½-knot W. by N. current; moderate NE. breeze.
10	Hyd. 148	74	crs. S	12	05	52	68	55	00	½-knot W. by N. current; Fort Rif light north (mag.) 1,800 feet.
18	Hyd. 149	410	yl. M. S	12	01	20	68	55	30	½ to ¾ knot W. current; fresh ENE. breeze.
18	Hyd. 150	733	yl. M. S	11	56	00	68	56	00	¾ to 1 knot W. current; fresh ENE. breeze.
18	Hyd. 151	738	yl. M. S	11	50	45	68	56	30	1-knot W. current; fresh ENE. breeze.
18	Hyd. 152	321	lt. gn. M. Grit	11	40	25	68	57	30	1-knot W. by S. current; moderate ENE. breeze.
18	Hyd. 153	138	gn. M	11	35	10	68	58	00	1-knot W. by S. current; light breeze.
18	Hyd. 154	45	lt. br. M	11	30	00	68	58	30	Astronomical position; Zamuro Point SE. (mag.); 1-knot W. by S. current; light ENE. breeze.
18	2124	122	gn. M. fne. Sh	11	34	30	69	02	10	1-knot W. by S. current; light ENE. breeze.
18	2125	208	yl. M. S. bk. Sp	11	43	00	69	09	30	
18	Hyd. 155	458	bu. M. fne. S	11	51	00	69	18	00	1 to 1½ knot W. by S. current; wind in squalls from ENE.
18	Hyd. 156	455	lt. gn. M. Grit	11	58	30	69	26	20	Do.
18	Hyd. 157	305	gn. M. crs. S	12	06	00	69	34	40	Do.
18	Hyd. 158	299	gn. M. Grit	12	13	30	69	43	00	Do.
19	Hyd. 159	420	gy. M	12	23	30	69	48	00	Light on east end Oruba Island W. ½ S. (mag.) 8 miles; about ½-knot westerly set.

Table of sounding and dredging stations occupied during the winter and spring—Continued.

Date.	Number.	Depth.	Bottom.	Latitude N.			Longitude W.			Remarks.
		Fathoms.		°	′	″	°	′	″	
Feb. 19	Hyd. 160	634	gy. M	12	32	50	69	50	00	Light SW. set; light ENE. breeze.
19	Hyd. 161	797	yl. M. crs. S. For	12	54	30	69	55	00	Light W. set; light ENE. breeze.
19	2126	1,701	yl. M. crs. S. For	13	17	45	70	01	00	1 knot NW. set; fresh ENE. breeze in squalls.
19	Hyd. 162	2,694	dk. br. M	13	40	20	70	10	45	½ to ¾ knot WSW. set; moderate ENE. breeze in squalls.
19	Hyd. 163	2,360	lt. br. M. S	14	24	00	70	28	20	1 to 1½ knots SW. set; moderate ENE. breeze in squalls.
20	Hyd. 164	2,338	lt. br. M. crs. S. For	15	09	20	70	46	50	1 to 1½ knots SW. set; moderate to fresh ENE. breeze.
20	Hyd. 165	2,209	lt. br. M. For	15	55	00	71	03	00	½ to 1 knot SW. set; moderate to fresh ENE. breeze.
20	Hyd. 166	2,028	lt. br. M. For	16	42	00	71	18	00	1½ knots SW. by W. set; moderate to fresh ENE. breeze.
21	Hyd. 167	522	lt. br. M. For	17	17	30	71	35	00	1½ knots SW. by W. set; moderate to fresh ENE. breeze.
21	Hyd. 168	302	wh. Co. S. brk. Sh	17	26	00	71	44	45	Alta Vela NE. ¼ E. (mag.) 4 miles.
21	Hyd. 169	2,410	wh. S. brk. Sh	17	36	30	72	00	00	1¼-knot SSW. current.
21	Hyd. 170	2,434		17	48	00	72	12	20	1-knot SSE. current. Old splice drew when half in; 35-pound lead.
21	Hyd. 171	1,929	gy. M. bk. S. brk. Co. Sh	18	01	30	72	23	00	1-knot SSE. current.
21	Hyd. 172	1,538	brk. Co. S	18	07	00	72	29	00	½ to 1 knot ESE. current.
21	Hyd. 173	253	bu. M	18	10	30	72	32	30	Jacmel NW. ¾ N. (mag.); Jacmel Point W. by S. (mag.); slight easterly set.
21	Hyd. 174	1,903	gy. M. bk. S. brk. Co. Sh	18	01	00	72	34	00	½-knot ESE. current.
21	Hyd. 175	1,594	lt. br. M. For	17	44	00	72	35	00	1 to 1½ knot SE. current.
22	Hyd. 176	1,946	yl. M. S. For	17	28	00	72	36	30	1¼-knot SE. by E. current; fresh ESE. wind.
22	Hyd. 177	2,391	br. M. For	17	12	45	72	38	00	Do.
22	Hyd. 178	2,393	br. Oz. For	17	24	45	72	47	00	1¼-knot ESE. current; fresh E. wind.
22	Hyd. 179	2,423	br. M. For	17	36	30	72	56	00	1-knot E. current; fresh E. wind.
22	Hyd. 180	2,391	br. Oz. For	17	45	30	73	04	00	1½-knot ENE. current.
22	Hyd. 181	2,490	br. Oz. For	17	39	30	73	22	15	1-knot NE. current.
22	Hyd. 182	2,369	br. Oz. For	17	48	00	73	34	15	1½-knot NE. current; moderate E. breeze.
22	Hyd. 183	1,039	gy. M. fne. S. For	17	54	00	73	48	15	No perceptible current; light E. breeze.
23	Hyd. 184	1,970	gy. M. S. For	17	53	30	73	59	30	About 1 knot ENE. set.
23	Hyd. 185	1,672	gy. M. fne. S. For	17	53	15	74	11	00	About 1½ knots ENE. set.
23	Hyd. 186	1,206	gy. M. fne. S. For	17	53	00	74	22	30	About 2 knots ENE. set.
23	Hyd. 187	894	S. M. Sh. For	18	01	00	74	31	45	About 1½ knots ENE. set.
23	Hyd. 188	894	yl. M. Sh. For	17	51	40	74	36	30	About 1 knot SE. set.
23	Hyd. 189	803	br. M. For	17	42	30	74	40	00	About ½ knot ESE. set.
23	Hyd. 190	955	yl. M. S. bk. Sp	17	33	30	74	45	00	About ½ knot N. and E. set.
23	Hyd. 191	1,146	gy. M. S. For	17	23	15	74	51	30	Slight set N. and E.
23	Hyd. 192	1,122	gy. M. S. For	17	13	15	74	57	45	
23	Hyd. 193	968	yl. M. fne. S	17	26	30	75	06	45	¼ to ½ knot N. set.
24	Hyd. 194	1,510	yl. M	18	02	00	74	57	30	Slight N. set.
24	Hyd. 195	262	hrd	18	18	30	74	53	30	Do.
24	Hyd. 196	1,040	gy. S	18	34	00	74	50	00	Do.
24	Hyd. 197	1,347	yl. M	18	45	00	74	32	40	Very slight ENE. set; calm.
24	Hyd. 198	1,537	yl. M	18	50	00	74	12	00	No current; light NW. breeze.
24	Hyd. 199	1,974	dk. M	18	56	00	73	51	00	Do.
24	Hyd. 200	342	hrd	18	59	40	73	30	00	No current.
24	Hyd. 201	800	yl. M. Sh. For	19	19	40	73	27	00	Do.

25	Hyd. 202	502	yl. M. S. Sh. For	19	16	30	73	47	30	Do.
25	Hyd. 203	700	yl. M	19	24	30	74	05	15	Do.
25	Hyd. 204	1,908	yl. M. brk. Sh. For	19	32	30	74	23	00	Do.
25	Hyd. 205	1,923	gy. M. fne. S. For	19	40	00	74	42	00	Do.
25	2127	1,639	gn. M	19	45	00	75	04	00	E. point Guantanamo Port NW. ½ W. (mag.). ½ knot about, WSW. set.
25	Hyd. 206	1,745	gy. M. S	19	43	21	75	15	30	E. point Guantanamo Port N. by W. (mag.). Barracas Point WNW. ¼ W. (mag.). Latitude by ✱ Rigel. No current.
25	Hyd. 207	1,380	gy. M. S. Sh	19	44	45	75	24	15	¼ to ½ knot E. set.
25	Hyd. 208	1,380	dk. M. bk. S. Sh	19	46	10	75	33	00	Do.
26	Hyd. 209	1,425	br. M. S. Sh	19	47	30	75	41	30	Do.
26	Hyd. 210	1,175	br. M. S. Sh	19	49	00	75	50	30	Santiago light N. by W. ½ W. (mag.) 8½ m. No current.
27	2128	400	bu. M. fne. S	19	55	46	75	49	23	Light W. set.
27	2129	274	bu. M. fne. S	19	56	01	75	48	55	Do.
27	2130	175	gy. M. S. brk. Sh	19	56	25	75	49	49	Do.
27	2131	202	brk. Co. S	19	56	44	75	50	49	
27	Hyd. 211	211	gy. M. fne. S. brk. Co	19	56	33	75	50	40	By bearing and mic. distance of Santiago de Cuba light, plotted in latitude 19° 57′ 26″, longitude 75° 52′ 13″. Light E. set.
27	2132	478	yl. M. brk. Sh	19	55	38	75	49	16	
27	2133	290	wh. S. brk. Sh	19	55	55	75	48	03	Do.
27	2134	254		19	56	06	75	47	32	Light E. set. Stray-line cut on rocks.
27	2135	262	brk. Co	19	55	58	75	47	07	Light E. set.
27	Hyd. 212	2,265	gy. M	19	40	00	75	39	00	No current.
28	Hyd. 213	2,275	br. M	19	23	00	75	30	00	Do.
28	Hyd. 214	1,768	yl. M. brk. Sh. For	19	06	00	75	21	30	Do.
28	Hyd. 215	1,486	yl. M. brk. Sh. For	18	54	30	75	16	30	Do.
28	Hyd. 216	870	wh. S. brk. Co. Sh	18	32	30	75	06	00	Do.
28	Hyd. 217	1,015	lt. M. Sh. For	18	34	00	75	21	00	N. set.
28	Hyd. 218	620	yl. M	18	32	40	75	36	00	About 1-knot NE. current.
28	Hyd. 219	646	brk. Sh	18	22	20	75	41	20	About 1¼-knot NE. current.
28	Hyd. 220	1,153	brk. Sh. bk. S	18	12	00	75	46	40	Do.
28	Hyd. 221	960	gy. M	18	01	30	75	52	00	Do.
29	Hyd. 222	450	gy. M. S	17	51	00	76	00	30	Bearing and dist. Morant light. NE. set.
29	Hyd. 223	762	yl. M	17	49	00	75	54	40	
29	Hyd. 224	768	yl. M. S	17	47	40	75	50	00	Slight northerly set.
29	Hyd. 225	830	yl. M	17	46	50	75	47	20	Do.
29	Hyd. 226	828	yl. M	17	46	15	75	45	30	Do.
29	Hyd. 227	443	Co. S	17	45	20	75	42	45	Do.
29	Hyd. 228	335	wh. S. brk. Sh	17	44	40	75	40	50	Do.
29	Hyd. 229	22	Co	17	43	55	75	39	00	Do.
29	Hyd. 230	86	Co. brk. Sh	17	43	37	75	38	05	Do.
29	Hyd. 231	98	Co	17	43	20	75	37	10	Do.
29	Hyd. 232	193	Co	17	44	20	75	37	40	
29	Hyd. 233	448	Co. brk. Sh	17	45	20	75	38	15	
29	Hyd. 234	540	Co	17	46	30	75	38	50	
29	Hyd. 235	387	wh. Co. S. brk. Sh	17	45	25	75	39	05	
29	Hyd. 236	23	Co	17	44	05	75	39	00	Anchored boat and established position.
29	Hyd. 237	22	Co	17	44	05	75	39	05	Bearing and distance of boat. No current.
29	Hyd. 238	21	wh. Co	17	43	35	75	38	55	Do.
29	Hyd. 239	20	Co	17	43	05	75	38	50	Do.
29	Hyd. 240	32	Co	17	42	35	75	38	45	Do.
29	Hyd. 241	200	Co. brk. Sh	17	42	10	75	38	40	Do.
29	Hyd. 242	376	Co. brk. Sh	17	42	15	75	37	40	Do.

Table of sounding and dredging stations occupied during the winter and spring—Continued.

Date.		Number.	Depth.	Bottom.	Latitude N.			Longitude W.			Remarks.
			Fathoms.		°	′	″	°	′	″	
Feb.	29	Hyd. 243	329	Co. brk. Sh.	17	42	20	75	36	40	Bearing and distance of boat; no current.
	29	Hyd. 244	198	Co. brk. Sh.	17	42	45	75	37	15	Do.
	29	Hyd. 245	166	Co. brk. Sh.	17	43	15	75	37	50	Do.
	29	2136	52	crs. brk. Sh	17	43	40	75	38	25	Do.
	29	2137	47	brk. Sh. Co.	17	44	50	75	39	20	Do.
	29	Hyd. 246	22	brk. Sh. Co.	17	44	00	75	39	40	Bearing and distance of boat; northerly current.
	29	Hyd. 247	21	brk. Sh. Co.	17	43	55	75	40	20	Do.
	29	Hyd. 248	81	brk. Sh. Co.	17	43	50	75	41	00	Do.
	29	Hyd. 249	141	brk. Sh. Co.	17	43	45	75	41	40	Do.
	29	Hyd. 250	21	Co	17	42	50	75	41	35	Do.
	29	Hyd. 251	23	Co	17	42	35	75	42	05	Do.
	29	Hyd. 252	24	Co. Sh	17	42	20	75	42	35	Do.
	29	Hyd. 253	261		17	42	05	75	43	05	Bearing and distance of boat; northerly current; wire parted.
	29	Hyd. 254	90	Co	17	41	25	75	43	05	Bearing and distance of boat; northerly current.
	29	Hyd. 255	20	Co	17	40	30	75	43	00	Do.
	29	Hyd. 256	19	Co	17	41	15	75	42	10	Do.
	29	Hyd. 257	21	Co	17	41	55	75	41	25	Do.
	29	Hyd. 258	20	Co	17	42	15	75	41	00	Do.
	29	Hyd. 259	21	Co	17	42	40	75	40	40	Do.
	29	2138	23	Co	17	44	05	75	39	00	Position of Hyd. 236.
	29	Hyd. 260	21	Co	17	42	50	75	39	20	
	29	Hyd. 261	20	Co	17	41	35	75	39	40	
	29	Hyd. 262	17½	Co	17	40	20	75	40	00	
	29	Hyd. 263	18½	Co	17	39	45	75	40	10	
	29	Hyd. 264	20	Co	17	39	10	75	40	20	Current to S. and E.
	29	Hyd. 265	20	Co	17	38	00	75	40	40	Do.
	29	Hyd. 266	51	Co	17	36	50	75	41	00	Do.
	29	Hyd. 267	19	Co	17	36	50	75	41	50	Do.
	29	Hyd. 268	18	Co	17	36	55	75	42	40	Do.
	29	Hyd. 269	20	Co	17	37	00	75	43	30	Do.
	29	Hyd. 270	19	Co	17	37	00	75	44	20	Do.
	29	Hyd. 271	524		17	37	05	75	45	15	Current to S. and E.; wire parted.
	29	Hyd. 272	18	Co	17	36	30	75	44	45	E. current.
	29	Hyd. 273	360	Co	17	36	00	75	44	15	Do.
	29	Hyd. 274	250	Co	17	36	00	75	45	10	Do.
	29	Hyd. 275	320	Co	17	36	05	75	46	10	Do.
	29	Hyd. 276	838	Co	17	36	30	75	48	00	Do.
	29	Hyd. 277	875	yl. M. Sh. For	17	37	35	75	52	10	Do.
Mar.	1	Hyd. 278	863	yl. M. S. Sh.	17	38	20	75	56	25	Do.
	1	Hyd. 279	597	yl. M. S. Sh.	17	39	10	76	00	35	Do.
	1	Hyd. 280	760	yl. M. S. Sh.	17	40	10	76	04	50	Bearing and distance of Morant light.
	1	Hyd. 281	414	yl. M. S. Sh.	17	41	20	76	09	40	E. current.
	1	Hyd. 282	490	hrd	17	42	30	76	14	30	Do.

1	Hyd. 283	612	Co	17	43	40	76	19	15	Do.
1	Hyd. 284	581	br. M	17	44	50	76	24	00	Cross-bearings of objects on shore; E. current.
1	Hyd. 285	590	yl. M	17	46	00	76	28	40	Do.
1	Hyd. 286	542	bu. M	17	47	00	76	33	10	Do.
1	Hyd. 287	777	gy. M. bk. S	17	48	10	76	37	50	Cross-bearings of objects on shore; no current.
1	Hyd. 288	484	gy. M	17	49	30	76	43	35	Cross-bearings of objects on shore; NW. current.
1	Hyd. 289	400	gy. M	17	51	20	76	44	30	Do.
11	Hyd. 290	440	bk. M	17	53	05	76	43	00	Cross-bearings on shore; no current.
11	Hyd. 291	18	Co	17	52	20	76	46	05	Do.
11	2139	215	bk. M	17	52	00	76	45	30	Do.
11	Hyd. 292	355	br. M. fne. S	17	48	45	76	46	05	Do.
11	Hyd. 293	26	Co	17	46	10	76	46	05	Do.
11	Hyd. 294	790	br. M. crs. S	17	41	10	76	46	05	
11	2140	966	S	17	36	10	76	46	05	
11	Hyd. 295	890		17	38	40	76	41	10	Wire parted.
12	Hyd. 296	980	bk. M. S	17	37	10	76	36	40	Slight set to W. by N.
12	Hyd. 297	1,043	gy. S	17	35	40	76	32	10	Do.
12	Hyd. 298	1,084	bu. M	17	34	10	76	27	40	Do.
12	Hyd. 299	933	Co	17	32	40	76	23	10	Do.
12	Hyd. 300	822	yl. M. Sh. For	17	29	40	76	14	10	Do.
12	Hyd. 301	808	yl. M. S	17	28	00	76	09	10	
12	Hyd. 302	790	hrd	17	26	45	76	04	10	
12	Hyd. 303	620	hrd	17	25	40	76	01	10	
12	2141	5	Co	17	25	00	75	59	55	Cross bearings on cays.
12	Hyd. 304	794	yl. M	17	31	10	75	58	00	
12	Hyd. 305	723	hrd	17	32	30	75	53	00	
12	Hyd. 306	218	Co	17	32	45	75	49	55	
12	Hyd. 307	490	hrd	17	32	50	75	48	20	
12	Hyd. 308	527		17	34	35	75	46	50	Wire parted.
12	Hyd. 309	505	gy. S	17	34	35	75	44	45	
12	Hyd. 310	500		17	34	35	75	43	40	Wire parted; reel was found to have crushed in.
12	Hyd. 311	515	S	17	34	35	75	39	35	About 1 knot WNW. set.
12	Hyd. 312	645	hrd	17	23	40	75	38	15	Do.
13	Hyd. 313	915	yl. M. S	17	12	00	75	36	30	Do.
13	Hyd. 314	1,012	yl. M. S. For	16	54	20	75	33	50	Do.
13	Hyd. 315	1,250	yl. M. S. For	16	31	00	75	30	10	Do.
13	Hyd. 316	1,230	yl. M. S. For	16	07	45	75	26	30	Do.
13	Hyd. 317	1,662	yl. M. S. For	15	43	00	75	24	30	Do.
13	Hyd. 318	2,295		15	18	30	75	22	30	About 1 knot WNW. set; wire parted.
14	Hyd. 319	2,315	yl. M. S. For	14	42	30	75	18	30	Do.
14	Hyd. 320	2,250	dk. br. M. For	14	06	30	75	14	30	About 1 knot W. set.
14	Hyd. 321	2,175	dk. br. M. S. For	13	30	00	74	57	00	About 1 knot WSW. set.
14	Hyd. 322	2,185	bk. M. For	12	53	30	74	38	00	Do.
15	Hyd. 323	2,095	bk. M. S	12	17	00	74	19	00	Do.
15	Hyd. 324	2,057	bk. S	12	11	30	74	27	30	1 to $1\frac{1}{4}$ knots W. set.
15	Hyd. 325	1,250	bk. M	11	46	00	74	27	30	Do.
15	Hyd. 326	745	bk. M	11	31	00	74	28	00	Do.
15	Hyd. 327	578	bu. M	11	21	00	74	28	00	Do.
15	Hyd. 328	420	bk. M. S	11	11	00	74	28	00	Do.
15	Hyd. 329	440	bk. S. bu. M	11	22	00	74	41	30	Do.
16	Hyd. 330	920	bk. S. bu. M	11	33	30	74	57	00	
16	Hyd. 331	615	bk. S. bu. M	11	18	30	74	58	20	E. set.

Table of sounding and dredging stations occupied during the winter and spring—Continued.

Date.	Number.	Depth.	Bottom.	Latitude N. °	′	″	Longitude W. °	′	″	Remarks.
		Fathoms.								
Mar. 16	Hyd. 332	457	bk. M	11	13	00	75	05	00	E. set.
22	Hyd. 333	10	bk. M	11	01	00	75	03	00	
22	Hyd. 334	39	bu. C	11	01	15	75	08	40	
22	Hyd. 335	228	bu. M	11	01	45	75	19	40	½ krot W. set.
22	Hyd. 336	625	bu. M	11	05	00	75	32	00	Do.
22	Hyd. 337	845	br. M	11	08	00	75	41	40	½ to 1 knot W. set.
22	Hyd. 338	1,195	br. M. gn. M	11	11	00	75	50	30	Do.
22	Hyd. 339	980	br. M. gn. M	10	56	00	75	49	50	
22	Hyd. 340	880	br. M. gn. M	10	42	30	75	49	00	NE. set.
22	Hyd. 341	825	br. M	10	30	30	75	48	30	½ to ¾ knot NE. set.
23	Hyd. 342	1,165	br. M	10	26	15	76	03	00	Do.
23	Hyd. 343	1,270	br. M	10	22	10	76	17	30	Do.
23	Hyd. 344	1,580	br. M	10	18	00	76	32	00	Do.
23	Hyd. 345	750	br. M	10	01	30	76	24	45	Do.
23	Hyd. 346	255	gn. M	9	46	00	76	18	30	Slight ENE. set.
23	Hyd. 347	38	gn. M. S	9	30	00	76	14	45	Do.
23	2142	42	gn. M. S	9	30	15	76	20	30	½ knot E. set.
23	2143	155	gn. M. S	9	30	45	76	25	30	Do.
23	Hyd. 348	466	hrd	9	32	00	76	34	45	Do.
23	Hyd. 349	960	br. M. gn. M	9	33	30	76	43	45	Do.
24	Hyd. 350	1,616	choc. Oz. For	9	36	20	77	02	45	¾ knot E. by S. set.
24	Hyd. 351	1,363	br. M. For	9	39	40	77	25	00	Do.
24	Hyd. 352	570	br. M. For	9	43	00	77	47	00	Do.
24	Hyd. 353	550	lt. br. M	9	44	40	77	56	00	Do.
24	Hyd. 354	630	br. M. S	9	47	00	78	09	30	Do.
24	Hyd. 355	1,017	br. M. S	9	48	00	78	24	00	
24	Hyd. 356	962	br. M	9	47	00	78	39	00	½ knot SE. set.
24	Hyd. 357	950	gy. M	9	45	30	78	54	00	Do.
24	Hyd. 358	1,060	sft. gy. M	9	47	00	79	03	00	½ knot E. set.
24	Hyd. 359	970	gn. M. br. M	9	48	30	79	11	45	Do.
25	Hyd. 360	828	gn. M. gy. M. Sh	9	51	15	79	20	30	½ knot ENE. set.
25	Hyd. 361	1,155	br. M. gn. M	9	54	00	79	30	00	SE. set.
25	2144	896	gn. M	9	49	00	79	31	30	Do.
25	Hyd. 362	580	bu. M	9	47	00	79	32	30	Do.
25	Hyd. 363	370	bu. M	9	45	15	79	34	00	Do.
25	Hyd. 364	58	bu. M	9	43	15	79	35	30	Do.
Apr. 2	2145	25	gn. M. brk. Sh	9	27	00	79	54	00	Cross-bearings of objects on shore.
2	2146	34	brk. Sh	9	32	00	79	54	30	Light SW. set.
2	2147	34	brk. Co	9	32	20	79	54	45	Do.
2	2148	130	hrd	9	35	00	79	55	30	Do.
2	Hyd. 365	707	stk. C	9	38	30	79	59	22	Do.
2	Hyd. 366	611	br. S	9	47	45	80	02	50	About 1 knot SW. set
2	Hyd. 367	1,153	gy. M	9	57	00	80	06	20	About 1¼ knots SW. set.

2	Hyd. 368	1,853	br. M. For	10	14	20	80	13	30	Do.
3	Hyd. 369	1,990	br. M. For	10	35	30	80	22	30	About 1 knot SW. set.
3	Hyd. 370	1,849	br. M	10	46	30	80	32	00	
3	Hyd. 371	1,832	br. M. For	11	20	00	80	42	10	Light E. set.
3	Hyd. 372	1,570	br. M. For	11	43	30	80	51	30	Light NW. set.
4	Hyd. 373	1,736	br. M. For	12	08	00	81	03	15	1 knot NW. set.
4	Hyd. 374	1,002	br. M. For	12	32	00	81	16	00	1¼ knots NW. set.
4	2149	992	yl. M	13	01	30	81	25	00	Do.
4	Hyd. 375	727	yl. M	13	12	00	81	27	20	1½ knots NW. set.
4	Hyd. 376	339	Co. S	13	16	05	81	26	40	1½ knots NW. set; cross bearings on Old Providence Island.
9	Hyd. 377	601	hrd	13	26	10	81	25	10	No current; cross-bearings on Old Providence Island.
9	Hyd. 378	472	fne. Co. S	13	30	30	81	23	30	Do.
9	2150	382	wh. Co. S	13	34	45	81	21	10	Do.
9	Hyd. 379	262	Co. S. For	13	41	20	81	15	30	Light NE. set.
9	Hyd. 380	498	yl. M. Co	13	45	15	81	11	30	Do.
9	Hyd. 381	625	hrd	13	53	15	81	03	45	Do.
9	Hyd. 382	577	Co. & S	14	01	20	80	56	10	Do.
9	Hyd. 383	596	yl. M	14	09	20	80	50	10	No appreciable current.
9	Hyd. 384	661	hrd	14	17	00	80	43	30	Do.
9	Hyd. 385	889	Co	14	25	45	80	37	45	Light NE. set.
10	Hyd. 386	982	yl. M. For	14	34	30	80	32	00	½ knot NE. current.
10	Hyd. 387	1,066	yl. M. For	14	43	20	80	26	00	Do.
10	Hyd. 388	1,069	yl. M. fne. Co	14	48	30	80	23	00	Do.
10	Hyd. 389	1,151	yl. M. fne. Co	14	53	40	80	20	00	Do.
10	Hyd. 390	971	yl. M. fne. Co	14	58	50	80	17	00	N. set.
10	Hyd. 391	756	yl. Co. Oz. For	15	09	00	80	23	00	1¼ knots NW. current.
10	Hyd. 392	690	yl. Co. Oz	15	19	00	80	28	45	1 to 1¼ knots NW. current.
10	2151	653	yl. Co. Oz	15	28	39	80	36	00	1 knot NW. current.
10	Hyd. 393	511	br. M. For	15	47	30	80	46	00	1 to 1½ knots NW. current.
10	Hyd. 394	19	Co	16	02	00	80	53	20	1 knot NW. current.
10	Hyd. 395	19	Co	16	15	00	81	01	00	No current.
10	Hyd. 396	23	Co	16	28	30	81	08	00	Do.
11	Hyd. 397	136	brk. Co	16	41	30	81	21	40	1 knot NW. by N. current.
11	Hyd. 398	444	gy. M. fne. Co. For	17	03	30	81	42	40	1 knot NW. by W. current.
11	Hyd. 399	920	yl. Oz. For	17	25	00	82	05	40	1½ knots NW. by W. current.
11	Hyd. 400	3,169	yl. Oz. For	17	42	00	82	34	00	2 knots WNW. current.
11	Hyd. 401	2,695	yl. Oz. For	18	01	30	82	54	10	2½ knots W. by N. current.
11	Hyd. 402	2,299	yl. Oz. For	18	18	45	83	01	10	Light E. set.
12	Hyd. 403	3,008	yl. Oz. For	18	24	20	83	15	15	2 knots WSW. current.
12	Hyd. 404	2,829	yl. Oz. For	18	30	00	83	16	30	1½ knots NW. by W. current.
12	Hyd. 405	735	yl. Oz. For. Pter	18	43	00	83	36	45	1 knot NW. current.
12	Hyd. 406	708	yl. Oz. For	18	48	30	83	45	30	¾ knot NW. current.
12	Hyd. 407	12	Co	18	49	00	83	46	45	Do.
12	Hyd. 408	14	Co	18	52	00	83	52	45	No appreciable current.
12	Hyd. 409	891	yl. Oz	18	54	45	83	53	45	NW. set.
12	Hyd. 410	2,014	yl. Oz. For	19	11	00	84	01	15	1½ knots NW. current.
12	Hyd. 411	2,522	yl. Oz. For	19	55	00	84	19	45	N. set.
13	Hyd. 412	2,575	yl. Oz. For	20	33	00	84	36	20	Do.
13	Hyd. 413	2,350	yl. Oz. For	21	15	41	84	48	00	Light NNE. set.
13	Hyd. 414	1,550	yl. Oz. For	21	40	00	84	57	00	½ to ¾ knot NNW. current.
13	Hyd. 415	950	yl. Oz. For	21	44	40	84	58	45	Bearing of Cape San Antonio Light, and altitude of * Capella.
14	Hyd. 419	1,356	yl. Oz. For	23	48	14	84	06	55	Light NE. set.

Table of sounding and dredging stations occupied during the winter and spring—Continued.

Date.	Number.	Depth.	Bottom.	Latitude N.			Longitude W.			Remarks.
		Fathoms.		°	′	″	°	′	″	
Apr. 30	2152	387	Co							2⅓ miles NW. of Havana light. (Approximate.)
30	2153	283	Co	23	10	19	82	23	10	Bearing and distance of Morro light. 1 knot westerly set.
30	2154	310	Co	23	10	16	82	22	54	Do.
30	2155	300	Co. S	23	10	21	82	22	44	Do.
30	2156	279	Co	23	10	35	82	21	55	Do.
30	2157	29		23	10	04	82	21	07	Do.
30	2158	86	Co	23	10	25	82	20	36	Do.
30	2159	98	Co	23	10	39	82	20	08	Do.
30	2160	167	Co	23	10	31	82	20	37	Do.
30	2161	146	Co	23	10	36	82	20	28	Do.
30	2162	122	Co	23	10	30	82	20	25	Do.
30	2163	133	Co	23	10	31	82	20	29	Do.
May 1	2164	192	Co	23	10	39	82	20	29	Do.
1	2165	200	Co	23	10	39	82	20	28	Do.
1	2166	196	Co	23	10	36	82	20	30	Do.
1	2167	201	Co	23	10	40	82	20	30	Do.
1	2168	122	Co	23	10	36	82	20	20	Do.
1	2169	78	Co	23	10	28	82	20	27	Do.
1	Hyd. 420	625	Co	23	06	00	83	03	45	Astronomical observation; cross-bearings on shore; 1½ knots W. set.
2	Hyd. 421	476	yl. Co. M	22	04	15	84	59	35	No apparent current.
2	Hyd. 422	243	Co	22	01	25	85	00	30	
2	Hyd. 423	314	Co	22	00	25	85	00	25	
2	Hyd. 424	355	Co	22	00	00	85	00	15	
2	Hyd. 425	357	Co	21	59	00	84	59	55	
2	Hyd. 426	279	Co	21	58	00	84	59	35	
2	Hyd. 427	370	fne. S	21	59	15	85	00	35	
2	Hyd. 428	15½	Co	22	00	42	85	02	00	Anchored boat and established position.
2	Hyd. 429	19	Co	22	01	10	85	02	20	
2	Hyd. 430	114	Co	22	01	30	85	02	40	
2	Hyd. 431	256	Co	22	01	20	85	03	30	
2	Hyd. 432	250	fne. Co	22	00	20	85	03	25	
2	Hyd. 433	207	Co	22	00	25	85	03	05	
2	Hyd. 434	128	Co	22	00	30	85	02	50	Meridian altitude of sun, two observers, sea horizon. Bearing of light.
2	Hyd. 435	16	Co	22	00	35	85	02	30	
2	Hyd. 436	252	Co. brk. Sh	22	00	10	85	02	15	
2	Hyd. 437	227	Co. brk. Sh	22	00	20	85	01	45	
2	Hyd. 438	15½	Co	22	00	48	85	01	30	
2	Hyd. 439	14½	Co	22	01	16	85	01	15	
2	Hyd. 440	16½	Co	22	01	44	85	01	00	
2	Hyd. 441	24½	Co. brk. Sh	22	02	12	85	01	45	
2	Hyd. 442	251	Co. br. R	22	02	40	85	00	30	
2	Hyd. 443	424	Co	22	02	45	85	01	50	
2	Hyd. 444	270	Co. brk. Sh	22	02	10	85	02	05	

2	Hyd. 445	21	Co	22	01	45	85	02	05	
2	Hyd. 446	16½	Co	22	01	15	85	02	05	
2	Hyd. 447	567	Co	22	04	18	85	02	15	
2	Hyd. 448	701	yl. Oz. For	22	05	50	85	04	30	
2	Hyd. 449	913	yl. Oz. For	22	07	20	85	06	45	
2	Hyd. 450	1,069	yl. Oz. For	22	08	55	85	09	00	
2	Hyd. 451	1,186	For. Pter	22	10	50	85	12	00	
2	Hyd. 452	1,238	For. Pter	22	09	40	85	18	40	Light easterly set.
2	Hyd. 453	1,149	Co	22	06	30	85	15	00	Do.
2	Hyd. 454	871	Co	22	03	50	85	11	55	Do.
2	Hyd. 455	277	Co	West of Antonio Knoll.						Position not satisfactorily established.
2	Hyd. 456	490	Co	West of Antonio Knoll.						Do.
3	Hyd. 457	450	Co	21	57	10	85	04	30	
3	Hyd. 458	576	Co	21	55	45	85	02	50	
3	Hyd. 459	402	Co	About 2½ miles WNW. of San Antonio light						Position not satisfactorily established.
3	Hyd. 460	689	Co	21	53	00	85	02	55	
3	Hyd. 461	618	Co	21	54	25	85	07	55	
3	Hyd. 462	691	Co	21	55	50	85	13	00	
3	Hyd. 463	608	Co	21	56	30	85	15	20	
3	Hyd. 464	850	Co	21	59	55	85	13	45	
3	Hyd. 465	543	Co	21	58	30	85	10	50	
3	Hyd. 466	487	Co. brk. Sh	21	57	00	85	08	00	
3	Hyd. 467	593	Co. brk. Sh	21	55	30	85	05	15	
3	Hyd. 468	523	Co	21	54	05	85	02	40	
3	Hyd. 469	558	Co	21	53	05	85	00	40	
3	Hyd. 470	541	Co. Oz	21	52	35	85	00	45	
3	Hyd. 471	629	Co. Oz	21	52	40	85	01	45	
3	Hyd. 472	692	Co. Oz	21	51	55	85	02	30	Light easterly current.
3	Hyd. 473	583	Co	21	52	10	85	05	30	Do.
3	Hyd. 474	885	Co. Oz	21	52	30	85	09	35	Do.
3	Hyd. 475	775	hrd	21	52	50	85	13	25	Do.
3	Hyd. 476	923	rky	21	49	45	85	13	25	Do.
3	Hyd. 477	887	rky	21	50	10	85	08	45	Do.
3	Hyd. 478	815	rky	21	50	45	85	04	10	Do.
3	Hyd. 479	263	rky	21	51	20	84	59	30	
3	Hyd. 480	342	Co	21	50	10	85	01	35	
3	Hyd. 481	674	Co	21	49	05	85	05	50	
3	Hyd. 482	937	Co. S	21	47	55	85	10	00	
3	Hyd. 483	1,023	Co. S	21	46	25	85	15	20	
3	Hyd. 484	1,062	fne. Co	21	43	20	85	14	00	
3	Hyd. 485	971	Co	21	45	30	85	10	00	
3	Hyd. 486	574	hrd	21	48	00	85	04	45	
3	Hyd. 487	306	hrd	21	50	20	84	59	30	
3	Hyd. 488	329	hrd	21	47	35	84	57	15	
4	Hyd. 489	874	Co. br. M	21	45	50	84	59	15	1¼ knots SE. current.
4	Hyd. 490	288	Co	21	48	00	84	57	30	Do.
4	Hyd. 491	232	Co	21	50	10	84	58	45	Light southerly set.
4	Hyd. 492	255	fne. Co	21	50	45	84	59	00	Do.
4	Hyd. 493	415	fne. Co	21	53	05	84	59	30	
4	Hyn. 494	537	Co	21	54	00	85	00	40	
4	Hyd. 495	516	hrd	21	55	00	85	01	50	

Table of sounding and dredging stations occupied during the winter and spring—Continued.

Date.	Number.	Depth.	Bottom.	Latitude N. °	′	″	Longitude W. °	′	″	Remarks.
		Fathoms.								
May 4	Hyd. 496	274	hrd	21	54	45	84	58	40	
4	Hyd. 497	475	Co	21	55	55	85	00	15	
4	Hyd. 498	474	Co. crs. G	21	57	10	85	01	50	
4	Hyd. 499	461	Co	21	58	25	85	03	40	
4	Hyd. 500	283	hrd	21	59	40	85	05	15	
4	Hyd. 501	703	yl. M	22	01	05	85	07	10	
4	Hyd. 502	732	yl. Oz. For	22	00	35	85	08	25	
4	Hyd. 503	776	hrd	22	00	05	85	09	40	
4	Hyd. 504	715	yl. Oz	21	59	20	85	08	40	
4	Hyd. 505	554	yl. Oz	21	59	10	85	06	55	
4	Hyd. 506	747	yl. Oz	21	59	50	85	07	45	
4	Hyd. 507	423	brk. Sh	21	58	30	85	06	10	
4	Hyd. 508	269	hrd	21	58	45	85	04	50	
4	Hyd. 509	657	yl. Oz	22	03	00	85	04	50	
4	Hyd. 510	526	yl. Oz	22	02	20	85	03	00	
5	Hyd. 511	600	co	22	07	05	85	02	45	
5	Hyd. 512	818	hrd	22	09	15	85	03	30	
5	Hyd. 513	986	yl. M. brk. Co	22	11	40	85	04	15	
5	Hyd. 514	953	yl. M. fne. Co	22	12	15	85	00	45	
6	Hyd. 515	769	yl. Oz. For	22	09	15	85	00	25	
6	Hyd. 516	499	yl. M	22	06	30	85	00	00	No current. N. end of Jutias Cay ENE. (mag.).
6	Hyd. 517	388	yl. Oz	22	41	20	84	15	00	Do. E. by S.
6	Hyd. 518	817	yl. Oz	22	45	20	84	15	00	Do.
6	Hyd. 519	950	fne. Co. S	22	49	20	84	15	00	
6	Hyd. 520	801	yl. Oz. S. For	22	50	10	84	11	00	
12	Hyd. 521	470	G. brk. Sh	30	46	00	78	35	00	No current.
14	Hyd. 522	2,537	br. Oz	34	14	00	72	35	30	Southerly set.
14	Hyd. 523	2,462	br. Oz	34	48	45	72	25	00	Do.

NOTE.—The latitudes of positions on Antonio Knoll are absolute; those of other soundings and the longitudes of all depend upon Cape San Antonio light being in latitude 21° 51′ 30″ N., longitude 84° 57′ 38″ W.

The statements of currents in the above table are based on careful estimates of their direction and strength while holding the sounding wire vertical, verified by their influence on the ship's reckoning between stations.

From these frequent observations it appears: (1) There is a general westerly drift throughout, as indicated on the charts, being strongest in the eastern part. (2) The currents appear to depend mainly on the wind, the direction of which they quickly follow approximately with a velocity proportioned to its force.

One exception to the first general rule was noted in latitude 12° to 12° 30′, longitude 62° 20′ to 62° 50′, where a slight set to the southward and eastward was experienced, the wind being light from ENE. It appears probable that vessels in this locality may be affected by the tidal currents of Grenada, although distant 40 to 60 miles from that island. The rule used by the island seamen for determining the time of the turn of the stream (see Navy Department H. O. Publication No. 63, page 554) is as follows: "From the time of the moon's rising until her superior transit or passing the meridian, the stream sets to the eastward; from the superior transit until she sets, it runs westward." While this vessel was in the area mentioned above, the moon was rising, which, according to the rule quoted, would account for the easterly set; the westerly set was again experienced two or three hours after the moon's meridian passage, increasing from that time on as the ship, moving southward, approached the western branch of the equatorial current flowing in between Grenada and Trinidad.

In connection with the second general statement made above, it should be observed that in the northern part of the Sea the set was generally to the southward of west, nearly following the winds; but south of the parallel of 12° or 12° 30′ the direction is to the northward of west, and usually quite strong—much more marked than farther north. For 100 miles northward of the Bocas de Dragos the current ran 2 to 3 knots an hour to NW., and farther to the NW. and W. (for 200 to 300 miles) it ran between NW. and W., also strong, in spite of the wind being in the NE. At the time of our visit to the Gulf of Paria (1st of February) the rainy season had not yet ended, and it is probable that the water from the Orinoco contributed to the stream in this vicinity. As far westward as longitude 66° 30, latitude 13°, a strong northwest current was experienced on the 8th of February.

Under the lee of Orchilla Island no current was perceptible, although running strong to NW. immediately north of it. In the broad channel between the Leeward Isles and the Main, the drift was to the southward of west until approaching Curaçao Island, when the current was found to be setting to about W. by N. The strength throughout here was ½ to ¾ knot.

Near the southern shores of Santo Domingo and Jamaica there are many eddies that may be somewhat tidal; but through them all is a

general easterly counter-set, of which advantage is frequently taken by the coasters in working to windward.

In the western part of the Caribbean Sea the strength of the westerly set is much less than farther east. Off the coast of the Isthmus of Panama there is not infrequently a counter-current to the eastward, which, although slight, is doubly perplexing from the fact that allowance is generally made for the usual westerly set. This may sometimes be accounted for by a continuance of northerly or northwesterly winds, but has at times been known to exist without that apparent cause.

In the broad channel between Yucatan and Honduras in the west and Cuba and Jamaica in the east the currents are extremely erratic. The amount of northwest drift in twenty-four hours was found generally to tally with what vessels have usually experienced there, being about 30 to 40 miles in a day; but during individual hours or portions of a day there were remarkable fluctuations noted. For instance, the current was WSW. 2½ knots an hour at one time; in two hours afterwards, just a few miles to the northward, it was setting feebly eastward; and again in two hours more, to southwest, and later on to the northwestward. This may be due to tidal influences, but it seems probable that the movement of the water is largely affected by the extraordinary variations in the depth, nearly 3,200 fathoms being found 75 miles eastward of Swan islet (60 feet high), 3,000 fathoms at 40 miles southeast of Misterioso Bank (10 fathoms), and so forth.

Fortunately while in this vicinity circumstances were very favorable for locating accurately each individual sounding, a bright moon lighting the horizon at night so that altitudes of stars could be observed at each station.

During the summer and autumn of 1884 hydrographic work was merely incidental, as continuous dredging and trawling generally interfered with the correct locating of the stations. Still, a number of the soundings taken were considered plotted with sufficient accuracy to be of hydrographic value. This work was off the United States coast between Cape Hatteras and George's Banks.

Nothing of special interest was definitely ascertained. But in the course of the season it became very evident that in the vicinity of the 40th parallel and the 70th and 71st meridians there is an easterly and a westerly movement of the water, alternating at intervals of apparently about half a day. Circumstances prevented a close examination into this matter, but, as the approximate time of the change of the current was noticed on several occasions to be later each day, it is believed that the phenomenon may be attributed to the influence of the moon, and that probably there may be tidal currents, less pronounced, but as regular there as along shore.

Indications were also found of a pocket running in northward from the 600-fathom line on about the meridian of 70° 15′, differing from the contour lines on existing charts. But, owing to cloudy weather and the

impossibility of keeping a good reckoning while trawling, the positions found were not considered sufficiently reliable to warrant making a report to the Hydrographic Office.

Table of sounding and dredging stations occupied during the summer and fall.

Date.	Number.	Depth.	Bottom.	Latitude N.			Longitude W.		
		Fathoms.		°	′	″	°	′	″
July 20	Hyd. 524	86	G	37	57	20	73	56	10
20	2170	155	gy. S	37	57	00	73	53	30
20	2171	444	gn. M	37	59	30	73	48	40
20	2172	568	gn. M	38	01	15	73	44	00
21	2173	1,600	Glob. Oz	37	57	00	72	34	00
21	2174	1,594	gy. M	38	15	00	72	03	00
22	Hyd. 525	79	gn. M. S	39	29	00	72	22	00
22	Hyd. 526	104	gn. M. S	39	30	00	72	18	00
22	Hyd. 527	197	stf. bu. C	39	32	00	72	18	20
22	2175	452	gn. M	39	33	00	72	18	30
22	Hyd. 528	121	gy. M. S	39	29	30	72	14	40
22	Hyd. 529	94	gn. M	39	28	00	72	16	00
22	Hyd. 530	91	bk. M. fne. S	39	27	40	72	18	30
22	Hyd. 531	73	bk. M. S	39	27	20	72	20	40
22	2176	302	bk. M	39	32	30	72	21	30
22	2177	87	gn. M. S	39	33	40	72	08	45
22	Hyd. 532	143	gy. S. bk. Sp	39	31	50	72	05	00
22	2178	229	gn. M. S	39	29	00	72	05	15
23	2179	510	bk. M	39	30	10	71	50	00
23	2180	523	bk. M	39	29	50	71	49	30
23	2181	693	gy. M. fne. S	39	29	00	71	46	00
23	2182	861	gn. M	39	25	30	71	44	00
23	Hyd. 533	992	gn. M. R	39	23	45	71	43	00
Aug. 2	Hyd. 534	172	gy. M. fne. S	40	00	00	70	38	00
2	Hyd. 535	139	gy. M. fne. S	40	01	30	70	38	00
2	Hyd. 536	101	gn. M. fne. S	40	03	00	70	38	00
2	2183	195	gn. M. S	39	57	45	70	56	30
2	Hyd. 537	168	gn. M. S	39	58	45	70	55	30
2	2184	136	gn. M. S	40	00	15	70	55	30
2	2185	129	gn. M. S	40	00	45	70	54	15
2	2186	353	gn. M	39	52	15	70	55	30
3	Hyd. 538	57	gy. S	40	04	30	71	20	00
3	Hyd. 539	100	gn. M. S. Sp	40	02	00	71	13	45
3	Hyd. 540	113	gn. M. S. bk. Sp	40	01	30	71	12	30
3	Hyd. 541	194	gn. M. S	39	56	30	71	10	00
3	2187	420	gn. M	39	49	30	71	10	00
3	Hyd. 542	192	gn. M. S	39	56	30	71	08	00
3	2188	235	gn. M. S	39	54	30	71	08	00
3	Hyd. 543	265	gn. M. S	39	54	00	71	04	00
3	Hyd. 544	221	gn. M. S	39	55	00	71	07	00
4	2189	600	gn. M	39	49	30	70	26	00
4	2190	1,180	gy. Glob. Oz	39	40	00	70	20	15
4	2191	961	gn. M	39	45	30	70	17	00
4	Hyd. 545	784	gn. M. S	39	47	00	70	16	30
5	Hyd. 546	762	gn. M	39	54	30	70	15	40
5	Hyd. 547	769	gn. M. S	39	50	30	70	15	40
5	2192	1,060	gy. Oz. St	39	46	30	70	14	45
5	2193	1,122	gn. M. hrd	39	44	30	70	10	30
5	2194	1,140	br. Oz	39	43	45	70	07	00
5	2195	1,058	gn. M	39	44	00	70	03	00
6	2196	1,230	gn. M	39	35	00	69	44	00
6	2197	84	crs. S. brk. Sh	39	56	30	69	43	20
6	2198	84	crs. S. brk. Sh	39	56	30	69	43	20
6	2199	78	gy. S	39	57	30	69	41	10
6	2200	148	crs. S. bk. Sp	39	53	30	69	43	20
19	Hyd. 548	111	gn. M. S	39	48	30	71	41	15
19	2201	538	bu. M	39	39	45	71	35	15
19	2202	515	gn. M	39	38	00	71	39	45
19	2203	705	gn. M. S	39	34	15	71	41	15
19	2204	728	br. M	39	30	30	71	44	30
20	2205	1,073	gy. Oz	39	35	00	71	18	45
20	2206	1,043	gn. M	39	35	00	71	24	30
20	2207	1,061	gn. M	39	35	33	71	31	45
20	Hyd. 549	925	gy. Oz	39	34	00	71	34	30
21	2208	1,178	gn. M. S	39	33	00	71	16	15
21	2209	1,080	Glob. Oz	39	34	45	71	21	30
21	2210	991	gy. Glob. Oz	39	37	45	71	18	45
21	2211	1,064	gn. M	39	35	00	71	18	00
22	2212	428	gn. M	39	59	30	70	30	45
22	Hyd. 550	243	gn. M	40	00	00	70	28	30
22	2213	384	gn. M	39	58	30	70	30	00

Table of sounding and dredging stations occupied during the summer and fall—Continued.

Date.	Number.	Depth.	Bottom.	Latitude N.			Longitude W.		
		Fathoms.		°	′	″	°	′	″
Aug. 22	2214	475	gn. M	39	57	00	70	32	00
22	Hyd. 551	356	gn. M	39	53	00	70	31	45
22	2215	578	(Lost lead)	39	49	15	70	31	45
22	2216	956	gn. M	39	47	00	70	30	30
23	2217	924	gy. M	39	47	20	69	34	15
23	2218	948	gy. M	39	46	22	69	29	00
23	2219	948	gy. M	39	46	22	69	29	00
23	2220	1,054	gy. M	39	43	00	69	23	00
23	Hyd. 552	1,094	bu. Oz	39	40	05	69	23	00
Sept. 6	2221	1,525	gy. Oz	39	05	30	70	44	30
6	2222	1,537	gy. Oz	39	03	15	70	50	45
7	2223	2,516	Glob. Oz	37	48	30	69	43	30
7	Hyd. 553	2,704	gy. Oz	37	41	00	69	16	15
8	2224	2,574	Glob. Oz	36	16	30	68	21	00
9	2225	2,512	yl. Oz	36	05	30	69	51	45
10	2226	2,045	Glob. Oz	37	00	00	71	54	00
10	2227	2,109	Glob. Oz	36	55	23	71	55	00
11	2228	1,582	br. M	37	25	00	73	06	00
11	Hyd. 554	1,600	gy. Glob. Oz	37	22	53	73	06	30
11	2229	1,423	Glob. Oz	37	38	40	73	16	30
12	2230	1,168	gy. Oz	38	27	00	73	02	00
12	2231	965	gy. Oz	38	29	00	73	09	00
12	2232	243	gn. M	38	37	30	73	11	00
12	Hyd. 555	190	gn. M. fne. S	38	38	20	73	10	00
12	2233	630	gn. M	38	36	30	73	06	00
12	Hyd. 556	474	gn. M	38	40	00	73	03	00
13	2234	810	gn. M	39	09	00	72	03	15
13	2235	707	gn. M	39	12	00	72	03	30
13	2236	636	gn. M	39	11	00	72	08	30
13	2237	520	gn. M	39	12	17	72	09	30
13	2238	904	gy. M	39	06	00	72	10	00
13	Hyd. 557	851	gn. M	39	08	30	72	12	30
26	2239	32	gn. M	40	38	00	70	29	45
26	Hyd. 558	37	gn. M	40	37	00	70	32	00
26	2240	44	gn. M	40	27	30	70	29	00
26	2241	50	gn. M	40	21	00	70	29	15
26	2242	58	gn. M	40	15	30	70	27	00
26	2243	63	gn. M	40	10	15	70	26	00
26	2244	67	gn. M. S	40	05	15	70	23	00
26	2245	98	gy. S. bk. Sp	40	01	15	70	22	00
26	2246	122	gn. M	39	56	45	70	20	30
27	2247	78	gn M. S	40	03	00	69	57	00
27	2248	67	gn. M. S. brk. Sh	40	07	00	69	57	00
27	2249	53	gn. M. fne. S	40	11	00	69	52	00
27	2250	47	gn. M. fne. S	40	17	15	69	51	45
27	2251	43	gy. M. fne. S	40	22	27	69	51	30
27	2252	38	gn. M. fne. bk. S	40	28	00	69	51	00
27	2253	32	gy. S. bk. Sp	40	34	30	69	50	45
27	2254	25	S. bk. Sp	40	40	30	69	50	30
27	2255	18	fne. S. bk. Sp	40	46	30	69	50	15
28	2256	30	yl. S	40	38	30	69	29	00
28	2257	33	yl. S. bk. Sp	40	32	30	69	29	00
28	2258	36	yl. S. bk. Sp	40	26	00	69	29	00
28	2259	41	gy. S. bk. Sp	40	19	30	69	29	10
28	2260	46	gy. S	40	13	15	69	29	15
28	2261	58	gy. S. brk. Sh	40	04	00	69	29	30
28	2262	250	gn. M. S	39	54	45	69	29	45
Oct. 18	2263	430	gn. M	37	08	00	74	33	00
18	2264	167	gy. S	37	07	50	74	34	20
18	2265	70	gn. M. G	37	07	40	74	35	40
18	Hyd. 559	54	S. G	37	07	30	74	37	00
19	2266	111	fne. S. brk. Sh	35	07	00	75	08	30
19	2267	68	gy. S	35	08	50	75	07	20
19	2268	68	gy. M	35	10	40	75	06	10
19	2269	48	crs. gy. brk. S	35	12	30	75	05	00
19	2270	32	fne. gy. S. bk. Sp	35	14	15	75	07	00
19	2271	26	crs. gy. S. brk. Sh	35	16	00	75	09	00
19	2272	15	crs. gy. S. brk. Sh	35	20	10	75	14	00
19	2273	17	gy. S. bk. Sp. brk. Sh	35	20	30	75	17	30
19	2274	16	gy. S. bk. Sp. brk. Sh	35	20	35	75	18	05
19	2275	16	gy. S. bk. Sp. brk. Sh	35	20	40	75	18	40
19	2276	16	gy. S. bk. Sp. brk. Sh	35	20	45	75	19	15
19	2277	16	gy. S. bk. Sp. brk. Sh	35	20	50	75	19	50
19	2278	16	gy. S. bk. Sp. brk. Sh	35	20	55	75	20	20
19	2279	16	gy. S. bk. Sp. brk. Sh	35	20	55	75	20	55
19	2280	16	gy. S. bk. Sp. brk. Sh	35	21	00	75	21	30
19	2281	16	gy. S. bk. Sp. brk. Sh	35	21	05	75	22	05
19	2282	14	bk. S	35	21	10	75	22	40
19	2283	14	gy. S	35	21	15	75	23	15
19	2284	13	crs. gy. S	35	21	20	75	23	30

Table of sounding and dredging stations occupied during the summer and fall—Continued.

Date.		Number.	Depth.	Bottom.	Latitude N.			Longitude W.		
			Fathoms.		°	′	″	°	′	″
Oct.	19	2285	13	crs. gy. S. bk. Sp	35	21	25	75	24	25
	19	2286	11	crs. gy. S	35	21	30	75	25	00
	20	2287	7	crs. S	35	22	30	75	26	00
	20	2288	7½	crs. S. bk. Sp	35	22	40	75	25	30
	20	2289	7	crs. S. bk. Sp	35	22	50	75	25	00
	20	2290	9¾	S. bk. Sp	35	23	00	75	24	30
	20	2291	15	gy. S. bk. Sp. brk. Sh	35	25	30	75	20	30
	20	2292	17	bk. gy. S. brk. Sh	35	27	20	75	16	30
	20	2293	18	crs. S. brk. Sh	35	29	10	75	12	30
	20	2294	16	crs. gy. S	35	31	00	75	08	30
	20	2295	22	crs. gy. S. bk. Sp	35	32	41	75	04	30
	20	2296	27	crs. yl. S	35	35	20	74	58	45
	20	2297	49	bk. M. S. brk. Sh	35	38	00	74	53	00
	20	2298	80	bk. M. S. brk. Sh	35	39	00	74	52	00
	20	2299	296	bk. M	35	40	00	74	51	30
	20	2300	671	bk. M	35	41	30	74	48	30
	21	2301	59	crs. S. brk. Sh	35	11	30	75	05	00
	21	2302	49	S. Co	35	14	00	75	03	00
	21	2303	41	fne. bk. gy. S	35	17	00	75	01	00
	21	2304	37	fne. bk. gy. S	35	19	00	74	58	00
	21	Hyd. 560	43	gy. bk. S	35	22	00	74	54	30
	21	2305	58	fne. bk. S	35	23	00	74	51	30
	21	Hyd. 561	1,007	gy. M	35	21	30	74	48	30
	21	2306	322	gy. M	35	21	30	74	52	00
	21	2307	43	gy. bk. S. brk. Sh	35	42	00	74	54	30
	21	2308	45	gy. bk. S. brk. Sh	35	43	00	74	53	30
	21	2309	56	gy. S. brk. Sh	35	43	30	74	52	00
	21	2310	132	bk. M. fne. Sh	35	44	00	74	51	00

In the preceding tables the abbreviations for the bottom are from the following code:

Abbreviation.	Meaning.	Abbreviation.	Meaning.	Abbreviation.	Meaning.
C	Clay.	Sp	Specks.	bk	black.
Co	Coral.	St	Stones.	br	brown.
For	Foraminifera.	brk	broken.	bu	blue.
G	Gravel.	crs	coarse.	choc	chocolate colored.
Glob	Globigerina.	fne	fine.	dk	dark.
M	Mud.	hrd	hard.	gn	green.
Oz	Ooze.	lge	large.	gy	gray.
P	Pebbles.	rky	rocky.	lt	light.
Pter	Pteropods.	sft	soft.	rd	red.
R	Rock.	sml	small.	slat	slate colored.
S	Sand.	stf	stiff.	wh	white.
Sh	Shells.	stk	sticky.	yl	yellow.

In the month of February the ship was swung in the Gulf of Paria, latitude 10° 30′ N., longitude 61° 35′ W. The azimuth of the sun was observed on every alternate point on even beam, swinging first with starboard and afterwards with port helm; and on every fourth point, while listed about 5° to port and 5¼° to 6¼° to starboard, swinging both times with starboard helm. From the mean deviation table, derived from the two swingings on even beam, a steering-card was constructed (see Plate I). In it the inner graduated circle shows the magnetic courses to be made; the lines radiating from it to the outer circle indicate on the latter the corresponding courses to be steered by the standard compass.

The effect on the deviation of listing to either side was similar to that

found in higher latitudes, though of course less marked. When listed to starboard the ship's head is thrown to windward when on courses north of east and west, and to leeward when on courses south of east and west. When listed to port the ship's head is thrown to windward when on any course west of north and south, and to leeward on any course east of north and south. The greatest difference caused by starboard list was on a southwest course, when the deviation was 11° 15′ E. as compared with 8° 30′ E. on even beam. The greatest change caused by port list was on a northwest course, when the deviation was 5° 15′ E. as compared with 2° 30′ E. on even beam.

In the month of July a magnetic survey of the vessel was made while in the dry dock of the navy-yard, Norfolk, Va., and the data sent to the Navy Department.

The general methods of navigation were as described in the report for 1883. The following examples will serve to illustrate the practical working of them:

EXAMPLE I.—On January 15 the problem was to sound over the position of Mourand Shoal, latitude 24° 35′ N., longitude 65° 13′ W. An altitude of the sun taken at 8.20 a. m., and worked out for latitudes 25° and 25° 10′ showed the ship to be somewhere on the line A B (Plate II). Clouds interfered with subsequent time-sights, but it was seen that if 12 miles were made on the same course (S. by E. $\frac{3}{4}$ E.) the ship would be on a line passing over Mourand Shoal and parallel to the line of position found at 8.20. So, when that distance had been made, it being believed that the ship was to the northeastward of the shoal, the course was changed to run southward along that line, and, as the hour of noon approached, ex-meridian altitudes were observed and computed in quick succession. Finally, a short time before noon, the latitude of 24° 35′ was reached. The ship was immediately stopped and the sounding begun, No. 39. The meridian altitude taken while sounding gave 24° 35′ 14″ as the latitude; and as no current was detected while sounding (3,006 fathoms), the vessel was presumably in the required longitude also.

EXAMPLE II.—During the night of April 11 and 12, while sounding at 8.15 p. m., altitudes of Sirius and Capella were taken and worked out for latitudes 18° and 18° 10′, placing the ship at Station No. 401, the intersection of the two lines of equal altitude. It was found necessary to steam ahead about 2½ knots an hour E. by S. to keep the wire vertical. The course was then shaped for the vigia, making allowance for the westerly current, and a sounding taken about midway. The current was here found to have changed to the eastward, quite feeble, and altitudes of Vega and Polaris showed the ship at No. 402. The difference between the intended and actual positions corroborated fairly the change of current. The course was then shaped for the vigia again, and a sounding taken a few miles southward of it so as to have a definite starting point not far from the desired position. The current was here found to be setting to the WSW. about 2 knots, and altitudes of

Polaris and Altair placed the ship at No. 403. The course was once more shaped for the vigia; a latitude by Polaris, plotted just before reaching it, and an altitude of the sun while reeling in, placed the vessel at No. 404. The current was here found running to the NW. by W. about 1½ knots.

EXAMPLE III.—On August 22, while sounding at Station No. 550, an altitude of the sun was observed; from there 2 miles were made on a SSW. course to No. 2213, where the sun was again observed while sounding; from here about two miles were made trawling towards SW. to No. 2214, and the sun again observed. In all these positions the sights were worked out for latitudes 39° 50′ and 40°, giving the lines shown. At half a mile southward of 2214 a meridian altitude of the sun gave the latitude 39° 56′ 35″. By plotting between all these lines a westerly set was detected, and the positions were fixed as in Plate III. From No. 2214 made about 8 miles in a southerly course to No. 2215, when the sun was again observed; then made about 2½ miles (trawling) to SSE., when another sounding was taken (No. 2216), and the sun again observed. Finally, after trawling about 2 miles to E. by S. from No. 2216, a meridian altitude of α Ophiuchi placed the ship in latitude 39° 46′ 50″. By working out the p. m. sights for latitudes 39° 40′ and 39° 50′ and plotting forward from the noon position, the westerly current was found to have stopped, and the positions were fixed as shown. In this case the depth was not sufficient to admit of any current being detected while sounding, but in the morning the vessel was drifted over the dredge-rope somewhat.

REPORT OF PASSED ASSISTANT ENGINEER G. W. BAIRD, U. S. N.

MAIN ENGINES.

During the year the engines have been in operation 1,652 hours while the ship was on her course in free route, besides the time occupied in sounding and dredging at sea, when the engines were worked to signals. The ship has steamed on her course in all weathers 13,388 miles, an average of 7.93 per hour, during which time the port engine made 6,333,776 and the starboard engine 6,316,140 revolutions, a mean of 63.8 per minute. It has been the custom to aim at economical rather than quick voyages, and the engines have been seldom run wide open, even with the reduced pressure of 50 pounds, which we are now carrying. The maximum speed recorded during the year is 10½ knots, while the highest average for ten hours is 10.44 knots per hour.

BOILERS.

During the year repairs have been made to the boilers whenever fires were permitted to be hauled. The crown sheets, which are of "mild

steel," and which were soft and ductile when new, are now brittle and so hard that they will turn the edges of steel tools unless they are tempered as hard as fire and water can make them. During the winter's voyage these sheets cracked in several places, but have been hard-patched since then. New leaks appear in the boilers, which we patch in turn. The braces are so close together in the boilers that the cost of removing them to repair a leak is sometimes greater than the absolute repairs.

STEAM-CUTTERS.

The two steam-cutters have been eminently satisfactory. Except the fracture of a feed-pump bracket, there have been no mishaps during the year. A new piston spring has been put in, and the air-pump connections have been bushed, there being no provisions to take up the wear. The propeller blades have been bent several times, but were straightened on board. New casings have been put on the boilers, new firebricks put in the furnaces, and new mineral wool put under the casings. We have found it necessary to make an alteration in the stern stuffing-box of the larger boat. The cost for repairs to the two boats during the year has been $110.57.

PUMPS.

The steam pumps continue to give satisfaction. We have put plugs in the "throw ports" of the circulating pump, to throttle the steam and retard the motion of the main steam-valve; it has the effect of making the pump linger a moment at the end of the stroke, which permits the valves to seat without slamming.

STEERING ENGINE.

The steering engine continues to do its work admirably whenever used (which is not often); but from the extensive surface of the joints on the exhaust side, the air-leaks impair our vacuum from 2 to 3 inches, when it is exhausted into the main condenser.

DREDGING ENGINE.

The dredging engine, having a great surplus of power, continues to do its work with ease. We have cut away parts of the cylinder heads to clear the frames, that we may take the heads off without taking down the engine frames.

REELING ENGINE.

The reeling engine continues to work well, requiring but few repairs.

STEAM WINDLASS.

The steam windlass continues to work well requiring but little attention.

SOUNDING ENGINE.

Except making a new piston spring and occasionally keying the journals, this engine has required no repairs. Since we cut the lap off the valve we have been able to get the engine started quicker, and also clear it of water more readily.

WARMING.

The steam radiators, though presenting a much less aggregate surface than is customary to provide for a ship of this size, have proved sufficient for the purpose. The traps which drain off the condensed water have required much attention, and I have put on a "blow-through" arrangement, which appears to improve the circulation.

VENTILATING.

The conduits, registers, and fan appear to be sufficient in every way, but the lack of power in the "Wise motor," which drives the fan, is such that we get a much smaller circulation than was intended. An experiment recorded in my report of September 30 gives the power and efficiency of the motor.

DISTILLER.

The distiller continues to furnish a plentiful supply of excellent water.

LIGHTING.

The Edison-light plant continues to give great satisfaction. During the year we have improvised submarine lamps, which the Naturalists use in catching squid and other marine fauna at night; they appear to attract a great variety of creatures. We have provided two clusters of three 16 candle-power lamps each, having cables 30 feet in length, for use on deck. These lamps were intended to light the trawl-sieves on deck, and have been so successful that the use of the arc-lamps has been discontinued. They require so much less current than the arc-lamp that the dynamo does not feel the additional load as it did from the arc-lamps. The cables are carried on convenient reels, one of which is fixed under the forecastle and one in the pilot-house. During the year two additional lamp-fixtures have been placed in the cabin. The usual breaking of wires and of sockets has continued; the repairs being made by our engine-room force. The lamp has been cut from the deep-sea cable, and the photometer of Paymaster Read has been put in its place; the current to operate the deep-sea photometer is taken from four Le Clanché disk cells. We have purchased a 7-inch belt, which drives the dynamo with less slipping. During the year the dynamo has been in operation 1,482 hours, giving practically the same economy as previously reported. The brightness of the lamps is unimpaired and the steadiness remains uniformly constant. The average number of lamps

in nightly use is about 47. The total cost of the light has been as follows:

$13\frac{1989}{2240}$ tons of coal	\$97 07
$92\frac{1}{2}$ gallons of oil	55 50
12 attachment plugs	3 90
7 brushes	7 00
5 cut-out blocks (additional)	1 70
39 3-light safety-plugs	2 73
6 6-light safety-plugs	48
1 20-light safety-plug	08
11 40-light safety-plugs	1 80
9 key-sockets	8 28
4 pounds insulation compound	48
5 feet of ⅜-inch rubber tubing	30
2 pounds insulation tape	96
3 deep-sea lamps	3 00
1 pound of No. 12 wire	40
1 pint of solution of gutta-percha	3 75
4 cigar-lighter plugs	2 20
¾ gross assorted screws	1 12
7 ounces hydrochloric acid	1 31
1 2-point switch	45
2 electroliers	1 50
141 lamps	141 00
Total	335 01

From this it appears that the light in candle-power per hour is costing us $\left(\frac{33501}{1482 \times 47 \times 8}=\right)$ 0.0601 cent per hour; about the cost of gas for an equal light in New York City. It is proper to add that the cost of coal during this year has averaged us \$6.99 per ton, and the entire expense in fixtures, wires, &c., are included, the item of labor alone being omitted, for the reason that no extra hands are employed for this purpose, the engine and dynamo being run by an enlisted man, in addition to his other duties in this department.

COAL EXPENDITURES.

During the year the expenditure of coal for the different purposes has been divided, approximately, as follows:

	Tons.
Coal consumed while the main engines were in operation for propulsion of the ship, warming, pumping bilges, washing decks, and steering	$864\frac{1453}{2240}$
Coal consumed for lighting the ship (by electricity)	$13\frac{1989}{2240}$
Coal consumed for ventilating	$50\frac{2008}{2240}$
Coal consumed for distilling water	$19\frac{1934}{2240}$
Coal consumed for warming the ship, keeping banked fires, hoisting anchors and trawls, and pumping water while the main engines were not running	$73\frac{465}{2240}$
Total coal consumed by the engineer's department	$1022\frac{1189}{2240}$
Coal for cooking (equipment department)	$54\frac{111}{2240}$

REPORT OF THE MEDICAL DEPARTMENT, BY JAMES M. FLINT, SURGEON, U. S. N.

The sanitary arrangements of the ship for ventilation, heating, lighting, &c., were very thoroughly considered by Passed Assistant Surgeon C. G. Herndon, U. S. Navy, in his General Medical Report for 1883. No changes have since been made which render further comment necessary. The system of forced ventilation by down-draft has demonstrated the possibility of supplying an abundance of fresh air to all parts of a ship. The question is reduced to one of expense merely, in the form of coal and labor. It only remains to convince those in authority that oxygen is an element as important to the animal tissues as carbon, hydrogen, and nitrogen; in other words, that a supply of fresh air is as necessary to the health, comfort, and cheerfulness of men, as is a liberal allowance of other food, now so generously provided for; and the question of expense will be quickly solved. The lavish hand that prepares the ration tables will not be less free in dealing out oxygen, when its necessity or even advantage shall be realized. I concur with the opinion of Dr. Herndon that for the best results the fan should be run continuously at a low speed, rather than intermittently at a high rate.

The general health of the ship's company during the year has been excellent. No severe accident or serious illness has occurred. Of the minor ailments few, if any, have been due to removable local conditions. The irritations of mucous membranes, as shown by catarrhs and slight bronchial affections, and the cellular inflammations resulting in abscesses and boils, are properly attributable to sudden changes of temperature, or strong local draughts of cold air, or to excessive humidity, but these conditions are for the most part irremediable, and must be reckoned among the unhealthful influences inseparable from the occupation of the mariner. It is only fair to state that other conditions than purely local ones tend to keep up the good health of the ship. The crew are all in the prime of life, no boys or old men among them; the period of enlistment is for one year only, thus permitting a weeding out of the less vigorous and the inefficient; the climatic conditions are most favorable, the ship cruising in northern waters in summer, and southern in winter; and while liberty is freely granted the men at all ports, yet the disposition to riotous forms of dissipation is much less than the average.

The determination and records of sea-water densities have been assigned to this departments. This work has been principally carried on by Mr. N. B. Miller, apothecary of this ship, and I can testify to the care and faithfulness with which it has been executed. The gravities of a few samples have been determined by actual weight by Dr. J. H. Kidder, and a comparison of results justifies a belief in the general accuracy of the work done on board. The instrument in use is the

cup and stem-float, in the combination known as Hilgard's salinometer. The water as soon as received is poured into bottles fitted with ground-glass stoppers, and is kept in the laboratory with the instrument until it has taken the temperature of the room. The water is carefully poured down the side of the cup to prevent the entanglement of air, which is liable to rise in bubbles, and adhering to the float, to vitiate the result. The float is carefully inserted so as to avoid wetting the stem above the line of flotation, and the graduation is read at the water level, through the little cone which rises around the stem. The rolling motion of the ship being very slight under all ordinary circumstances of weather, and the laboratory being situated near the center of fore and aft movement, it is possible to attain here nearly the accuracy that could be expected from the use of the same instruments on shore.

Appended are the records of specific gravities (marked A).

Particular attention is called to the interesting series of surface gravities taken on May 15th and 16th, during the passage of the ship from the Gulf Stream up Chesapeake Bay and the Potomac, and again on a similar trip. The gradual and regular diminution of density and the variability under differing conditions are well shown by the figures.

Through the courtesy of the Coast Survey Office an instrument for measuring the specific gravity of sea-water, known as Hilgard's optical densimeter, has been received. The instrument is fully described in Coast Survey Report for 1877, Appendix No. 10. Much time has been spent in the effort to become thoroughly acquainted with the use of the instrument and to determine its advantages, if any, and its accuracy in actual practice. After many trials, extending over a period of several months, I am compelled to say that, in its present form at least, it is less reliable and much more difficult to use than the old stem-float.

The following series of trials (marked B) with distilled water illustrates the unreliability of the instrument in my hands. For each experiment the densimeter was taken from its case, the prismatic bottle filled from a large jar of distilled water, and after the examination the bottle emptied and corked and the instrument returned to its case. All the appliances, were kept together and were of uniform temperature at the time of the experiment. Every precaution was taken to make the conditions always the same and to secure the greatest possible accuracy in the reading. As will be seen, there is an extreme variation in the series of 14.2 micrometer divisions, and as each division represents a change of .00007026 in density, the possible error in determining the gravity of distilled water mounts up to .001. No satisfactory explanation has been reached of the causes of the sudden changes observed in the tables. The probable error in reading the micrometer should not exceed 3 divisions, and the error in reading the thermometer must be less than .5°.

There is also appended a table (marked C), showing the comparative results with this instrument and the salinometer, using specimens of

sea-water obtained on three successive days. Before examining the specimens, the constant of the densimeter for distilled water was determined for that day by taking the average of three trials. The readings are generally a little lower, but not greatly different from those obtained by the salinometer.

A.—*Specific gravities of sea-water.*

Date.	Time of day.	Station.	Latitude N.	Longitude W.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Reduced to 60° F.
1884.			° ′ ″	° ′ ″		°	°	°		
Jan. 24	7.30 p.m.	Hyd. 47	17 46 30	65 10 25	Surface.	78	77	88	1.0234	1.028104
24	7.30 p.m.	Hyd. 47	17 46 30	65 10 25	50	78	77	88	1.0340	1.028704
24	7.30 p.m.	Hyd. 47	17 46 30	65 10 25	100	67	77	87	1.0242	1.028709
24	7.30 p.m.	Hyd. 47	17 46 30	65 10 25	200	....	77	87	1.0242	1.028709
24	7.30 p.m.	Hyd. 47	17 46 30	65 10 25	300	....	77	87	1.0242	1.028709
24	7.30 p.m.	Hyd. 47	17 46 30	65 10 25	400	45	77	86	1.0230	1.027316
24	7.30 p.m.	Hyd. 47	17 46 30	65 10 25	500	....	77	87	1.0230	1.027509
24	7.30 p.m.	Hyd. 47	17 46 30	65 10 25	600	....	77	86	1.0240	1.028316
24	7.30 p.m.	Hyd. 47	17 46 30	65 10 25	700	40	77	......	....	(*)
24	7.30 p.m.	Hyd. 47	17 46 30	65 10 25	800	....	77	87	1.0230	1.027509
24	7.30 p.m.	Hyd. 47	17 46 30	65 10 25	900	40	77	87	1.0230	1.027509
24	7.30 p.m.	Hyd. 47	17 46 30	65 10 25	1,000	....	77	87	1.0240	1.028509
28	5.00 p.m.	Hyd. 83	13 23 00	62 34 15	Surface.	77	76	89	1.0234	1.028330
28	5.00 p.m.	Hyd. 83	13 23 00	62 34 15	25	77	76	87	1.0242	1.028709
28	5.00 p.m.	Hyd. 83	13 23 00	62 34 15	50	69	76	87	1.0242	1.028709
28	5.00 p.m.	Hyd. 83	13 23 00	62 34 15	100	61.25	76	87	1.0240	1.028509
28	5.00 p.m.	Hyd. 83	13 23 00	62 34 15	200	50	76	87	1.0236	1.028109
28	5.00 p.m.	Hyd. 83	13 23 00	62 34 15	300	45	76	88	1.0230	1.027704
28	5.00 p.m.	Hyd. 83	13 23 00	62 34 15	400	43.5	76	88	1.0228	1.027504
28	5.00 p.m.	Hyd. 83	13 23 00	62 34 15	500	....	76	88	1.0232	1.027904
28	5.00 p.m.	Hyd. 83	13 23 00	62 34 15	600	40.7	76	88	1.0230	1.027704
28	5.00 p.m.	Hyd. 83	13 23 00	62 34 15	700	40.2	76	89	1.0226	1.027530
28	5.00 p.m.	Hyd. 83	13 23 00	62 34 15	800	40	76	89	1.0226	1.027530
29	1.00 p.m.	Dredge 2119	11 48 30	62 17 30	Surface.	77	75	80	1.0250	1.028160
29	1.00 p.m.	Dredge 2119	11 48 30	62 17 30	25	75.75	75	78	1.0256	1.028408
29	1.00 p.m.	Dredge 2119	11 48 30	62 17 30	50	69.25	75	76	1.0260	1.028432
Feb. 3	9.00 a.m.	Dredge 2122	10 37 00	61 44 22	Surface.	78	77	81	1.0208	1.024239
3	10.00 a.m.	Dredge 2123	10 42 02	61 48 48	...do....	76	77	78	1.0208	1.023783
3	11.00 a.m.	Hyd. 101	10 54 00	61 53 40	...do....	77	77	78	1.0210	1.023808
3	12.00 m.	Hyd. 102	11 02 30	62 06 00	...do....	77	77	80	1.0230	1.026160
3	12.00 m.	Hyd. 102	11 02 30	62 06 00	5	76	77	79	1.0232	1.026183
3	12.00 m.	Hyd. 102	11 02 30	62 06 00	25	70	77	76	1.0252	1.027632
3	2.45 p.m.	Hyd. 103	11 19 00	62 22 00	Surface.	77	77	80	1.0252	1.028360
3	5.00 p.m.	Hyd. 104	11 34 20	62 38 15	...do....	78	78	81	1.0252	1.028539
3	7.30 p.m.	Hyd. 105	11 45 30	63 01 00	...do....	77	76	81	1.0248	1.028139
4	8.30 a.m.	Hyd. 109	12 22 50	64 38 00	...do....	78	78	80	1.0250	1.028160
4	1.00 p.m.	Hyd. 110	12 41 00	64 22 00	...do....	78	78	80	1.0250	1.028160
4	5.30 p.m.	Hyd. 111	12 59 20	64 08 00	...do....	77	75	80	1.0251	1.028260
5	8.00 a.m.	Hyd. 115	14 07 10	63 37 55	...do....	77	75	79	1.0252	1.028183
5	12.00 m.	Hyd. 116	14 21 44	63 58 45	...do....	77	77	80	1.0251	1.028260
5	3.00 p.m.	Hyd. 117	14 35 10	64 21 10	Surface.	78	78	80	1.0252	1.028360
5	7.00 p.m.	Hyd. 118	14 51 00	64 42 00	...do....	77	75	79	1.0254	1.028383
6	9.00 a.m.	Hyd. 120	16 01 00	65 56 20	...do....	77	78	79	1.0252	1.028183
6	9.00 a.m.	Hyd. 120	16 01 00	65 56 20	5	77	78	80	1.0250	1.028160
6	9.00 a.m.	Hyd. 120	16 01 00	65 56 20	25	77.5	78	80	1.0248	1.027960
6	4.00 p.m.	Hyd. 121	16 36 20	66 41 00	Surface.	77	80	80	1.0250	1.028160
7	9.00 a.m.	Hyd. 123	15 49 00	67 36 40	...do....	77	74	80	1.0250	1.028160
7	5.00 p.m.	Hyd. 124	15 02 00	67 13 20	...do....	78	75	86	1.0238	1.028116
7	5.00 p.m.	Hyd. 124	15 02 00	67 13 20	25	77.75	75	87	1.0234	1.027909
7	5.00 p.m.	Hyd. 124	15 02 00	67 13 20	50	78	75	86	1.0240	1.028316
7	5.00 p.m.	Hyd. 124	15 02 00	67 13 20	100	66.6	75	87	1.0242	1.028709
7	5.00 p.m.	Hyd. 124	15 02 00	67 13 20	200	53	75	87	1.0234	1.027909
7	5.00 p.m.	Hyd. 124	15 02 00	67 13 20	300	....	75	87	1.0230	1.027509
7	5.00 p.m.	Hyd. 124	15 02 00	67 13 20	400	....	75	88	1.0225	1.027204
7	5.00 p.m.	Hyd. 124	15 02 00	67 13 20	500	....	75	87	1.0228	1.027309
7	5.00 p.m.	Hyd. 124	15 02 00	67 13 20	600	....	75	88	1.0226	1.027304
7	5.00 p.m.	Hyd. 124	15 02 00	67 13 20	700	41	75	88	1.0226	1.027304
7	5.00 p.m.	Hyd. 124	15 02 00	67 13 20	800	40	75	88	1.0226	1.027304

*No water in cup.

A.—*Specific gravities of sea-water*—Continued.

Date.	Time of day.	Station.	Latitude N.	Longitude W.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Reduced to 60° F.
1881.			° ′ ″	° ′ ″		°	°	°		
Feb. 8	8.00 a.m.	Hyd. 126	13 40 00	66 35 00	Surface.	77	77	80	1.0251	1.028260
8	11.00 a.m.	Hyd. 127	13 25 04	66 25 00	...do....	77	78	80	1.0252	1.028360
8	4.30 p.m.	Hyd. 128	12 54 40	66 11 10	...do....	78	80	80	1.0250	1.028160
9	8.40 a.m.	Hyd. 133	11 33 20	66 19 00	...do....	75	76	78	1.0256	1.028408
9	11.00 a.m.	Hyd. 134	11 18 50	66 24 20	...do....	76	78	79	1.0256	1.028583
9	3.00 p.m.	Hyd. 136	10 51 00	66 35 00	...do....	77	80	80	1.0254	1.028560
9	6.30 p.m.	Hyd. 138	10 51 30	67 01 40	...do....	75	74	77	1.0258	1.028418
10	8.30 a.m.	Hyd. 144	11 46 40	68 19 50	...do....	77	76	79	1.0254	1.028383
10	10.30 a.m.	Hyd. 145	11 52 00	68 35 40	...do....	77	76	79	1.0254	1.028383
10	12.30 p.m.	Hyd. 146	11 55 20	65 46 00	...do....	77	78	79	1.0253	1.028283
10	1 15 p.m.	Hyd. 147	11 59 00	68 49 00	...do....	77	79	79	1.0252	1.028183
10	3.00 p.m.	Hyd. 148	12 05 52	68 55 00	...do....	77	80	79	1.0252	1.028183
11	12.00 m...	....	Harbor Curaçao.		...do...	75	78	79	1.0256	1.028583
18	8.30 a.m.	Hyd. 149	12 01 20	68 55 30	...do....	75	75	77	1.0260	1.028618
18	10.00 a.m.	Hyd. 151	11 50 45	68 56 30	...do....	75	75	77	1.0260	1.028618
18	12.00 m.	Hyd. 153	11 35 10	68 58 00	...do....	75	77	77	1.0260	1.028618
18	1.00 p.m.	Hyd. 154	11 30 00	68 58 30	.. do ...	75	76	76	1.0261	1.028532
18	2.00 p.m.	Dredge 2124	11 34 30	69 02 10	...do....	74	76	76	1.0261	1.028532
18	4.00 p.m.	Dredge 2125	11 43 00	69 09 30	...do....	74	76	76	1.0261	1.028532
18	7.00 p.m.	Hyd. 155	11 51 00	69 18 00	...do....	74	75	77	1.0260	1.028618
19	9.30 a.m.	Dredge 2126	13 17 45	70 01 00	...do....	76	79	79	1.0254	1.028383
19	4.30 p.m.	Hyd. 162	13 40 20	70 10 45	...do....	76	79	79	1.0253	1.028283
20	1.30 p.m.	Hyd. 165	15 55 00	71 03 00	...do....	77	81	80	1.0250	1.028160
20	8.00 p.m.	Hyd. 166	16 42 00	71 18 30	...do....	75	78	79	1.0248	1.027783
21	7.00 a.m.	Hyd. 169	17 36 30	72 00 00	...do ...	75	79	79	1.0246	1.027583
21	9.30 a.m.	Hyd. 170	17 48 00	72 12 20	...do....	77	79	80	1.0246	1.027760
21	1.30 p.m.	Hyd. 171	18 01 30	72 23 00	...do....	78	82	81	1.0244	1.027739
21	3.00 p.m.	Hyd. 172	18 07 00	72 29 00	..do ...	78	79	80	1.0246	1.027760
21	3.00 p.m.	Hyd. 172	18 07 00	72 29 00	25	78	79	81	1.0246	1.027939
21	3.00 p.m.	Hyd. 172	18 07 00	72 29 00	50	77	79	81	1.0268	1.028139
21	4.30 p.m.	Hyd. 173	18 10 30	72 32 30	Surface.	77	79	80	1.0242	1.027360
21	6.30 p.m.	Hyd. 174	18 01 00	72 34 00	..do....	77	78	83	1.0244	1.028126
22	7.00 a.m.	Hyd. 178	17 24 45	72 47 00	...do....	76	76	79	1.0250	1.027983
22	10.00 a.m.	Hyd. 179	17 36 30	72 56 00	...do....	76	78	80	1.0247	1.027860
22	12.30 p.m.	Hyd. 180	17 45 30	73 04 00	...do....	78	78	80	1.0246	1.027760
22	4.00 p.m	Hyd. 181	17 39 30	73 21 15	...do....	78	80	80	1.0244	1.027560
22	7.00 p.m.	Hyd. 182	17 48 00	73 24 15	...do....	77	78	80	1.0246	1.027760
23	9.00 a.m.	Hyd. 187	18 01 00	74 31 45	...do....	77	74	80	1.0250	1.028160
23	11.00 a.m.	Hyd. 188	17 51 40	74 36 30	..do....	77	76	80	1.0250	1.028160
23	2.00 p.m.	Hyd. 190	17 33 30	74 45 00	...do....	77	80	80	1.0246	1.027760
23	6.00 p.m.	Hyd. 192	17 13 15	74 57 45	...do....	77	78	80	1.0246	1.027760
24	10.00 a.m.	Hyd. 197	18 45 00	74 32 40	...do....	78	80	81	1.0250	1.028339
24	1.00 p.m.	Hyd. 198	18 30 00	74 12 00	...do....	80	84	81	1.0246	1.027939
24	4.00 p.m.	Hyd. 199	18 56 00	73 51 00	...do....	79	80	81	1.0246	1.027939
24	7.00 p.m.	Hyd. 200	18 59 40	73 30 00	...do....	78	78	81	1.0248	1.028139
25	10.00 a.m	Hyd. 205	19 40 00	74 42 00	...do ...	78	78	80	1.0250	1.028160
25	1.00 p.m.	Dredge 2127	19 45 00	75 04 00	...do....	78	78	81	1.0250	1.028339
26	12.00 m.	....	Santiago de Cuba.		...do....	82	82	84	1.0246	1.028512
27	12.00 m.	Dredge 2128	19 55 46	75 49 23	...do....	79	80	81	1.0250	1.028339
28	9.00 a.m.	Hyd. 215	18 54 30	75 16 30	...do....	78	78	80	1.0248	1.027960
28	1.30 p.m.	Hyd. 216	18 32 30	75 06 00	...do....	78	78	81	1.0248	1.028139
28	6.00 p.m.	Hyd. 218	18 32 40	75 30 00	...do....	78	78	80	1.0250	1.028160
29	8.00 a.m.	Hyd. 226	17 46 15	75 45 30	...do....	78	77	81	1.0247	1.028039
29	1.00 p.m.	Hyd. 243	17 42 20	75 36 40	...do....	78	79	81	1.0246	1.027939
29	5.30 p.m.	Dredge 2138	17 44 05	75 39 00	...do....	77	78	81	1.0246	1.027939
Mar. 1	8.00 a.m.	Hyd. 286	17 47 00	76 33 10	...do....	77	78	80	1.0248	1.027960
1	10.30 a.m.	Hyd. 288	17 49 30	76 43 35	...do....	78	79	81	1.0244	1.027739
1	11.00 a.m.	Hyd. 289	17 51 20	76 44 30	..do ...	78	80	81	1.0244	1.027739
6	12.00 m.	....	Kingston, Jamaica.		..do ...	78	80	80	1.0246	1.027760
11	6.00 p.m.	Hyd. 294	17 41 10	76 46 05	...do...	78	78	79	1.0256	1.028583
12	4.00 p.m.	Hyd. 305	17 32 30	75 33 00	...do....	78	79	78	1.0252	1.028008
13	11.30 a.m.	Hyd. 316	16 07 45	75 26 30	...do ...	76	77	78	1.0250	1.027808
13	3.30 p.m.	Hyd. 317	15 43 00	75 24 30	...do ...	77	79	79	1.0250	1.027983
14	8.30 a.m.	Hyd. 320	14 06 30	75 14 30	..do....	75	77	78	1.0260	1.028808
14	3.00 p.m	Hyd. 321	13 30 00	74 57 00	...do....	76	80	77	1.0264	1.029018
15	8.30 a.m.	Hyd. 324	12 11 30	74 27 30	...do....	75	77	77	1.0260	1.028618
15	1.00 p.m.	Hyd. 325	11 46 00	74 27 30	...do....	75	77	76	1.0260	1.028432
15	4.30 p.m.	Hyd. 327	11 21 00	74 23 00	.. do....	75	79	77	1.0260	1.028618
20	11.00 a.m.	....	Savanilla, U. S. C.		...do....	74	79	75	1.0262	1.028465
22	11.00 a.m.	Hyd. 337	11 01 15	75 08 40	...do....	75	76	76	1.0256	1.028032
22	1.30 p.m.	Hyd. 336	11 05 00	75 32 00	...do....	75	77	77	1.0256	1.028218

A.—*Specific gravities of sea-water*—Continued.

Date.	Time of day.	Station.	Latitude N.	Longitude W.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Reduced to 60° F.
1884.			° ′ ″	° ′ ″		°	°	°		
Mar. 22	7.30 p.m.	Hyd. 339	10 56 00	75 49 50	...do	77	77	78	1.0254	1.028208
23	10.00 a.m.	Hyd. 345	10 01 30	76 24 45	...do	79	79	80	1.0250	1.028160
23	1.00 p.m.	Hyd. 346	9 46 00	76 18 30	...do	82	82	82	1.0246	1.028120
23	7.15 p.m.	Hyd. 348	9 32 00	76 34 45	...do	79	78	80	1.0253	1.028460
24	9.00 a.m.	Hyd. 352	9 43 00	77 47 00	...do	76	80	79	1.0256	1.028583
24	1.00 p.m.	Hyd. 354	9 47 00	78 09 30	...do	79	79	80	1.0253	1.028460
24	6.00 p.m.	Hyd. 356	9 47 00	78 39 00	...do	79	78	79	1.0252	1.028183
25	11.00 a.m.	Hyd. 363	9 45 15	79 34 00	...do	80	79	80	1.0250	1.028160
Apr. 2	9.30 a.m.	....	Harbor of Colon.		...do ..	79	80	81	1.0250	1.028339
2	12.00 m.	Dredge 2146	9 32 00	79 54 30	...do ...	79	79	81	1.0252	1.028539
2	7.30 p.m.	Hyd. 367	9 57 00	80 06 20	...do ...	78	78	81	1.0254	1.028739
3	8.00 a.m.	Hyd. 370	10 46 30	80 32 00	...do ...	79	80	80	1.0254	1.028560
3	1.00 p.m.	Hyd. 371	10 46 30	80 32 00	...do ...	79	79	80	1.0254	1.028560
3	1.00 p.m.	Hyd. 371	10 46 30	80 32 00	25	78	79	80	1.0262	1.029360
3	1.00 p.m.	Hyd. 371	10 46 30	80 32 00	100	64	79	74	1.0261	1.028486
3	1.00 p.m.	Hyd. 371	10 46 30	80 32 00	300	46.5	79	76	1.0274	1.029832
3	1.00 p.m.	Hyd. 371	10 46 30	80 32 00	500	40.7	79	74	1.0251	1.027186
3	1.00 p.m.	Hyd. 371	10 46 30	80 32 00	700	39.8	79	74	1.0260	1.028086
3	1.00 p.m.	Hyd. 371	10 46 30	80 32 00	900	39.5	79	73	1.0260	1.027924
4	9.30 a.m.	Dredge 2149	13 01 30	81 25 00	Surface.	78	79	79	1.0256	1.028583
9	8.30 a.m.	Hyd. 378	13 30 30	81 23 30	...do ...	78	82	79	1.0260	1.028983
9	12.00 m.	Hyd. 379	13 41 20	81 15 30	...do	79	82	79	1.0257	1.028683
10	9.00 a.m.	Hyd. 392	15 09 00	80 28 45	...do	78	80	78	1.0256	1.028408
10	1.00 p.m.	Dredge 2151	15 28 39	80 36 00	...do	79	80	80	1.0256	1.028760
10	1.00 p.m.	2151	15 28 39	80 36 00	50	77.5	80	79	1.0256	1.028583
10	1.00 p.m.	2151	15 28 39	80 36 00	200	55.5	80	76	1.0260	1.028432
10	1.00 p.m.	2151	15 28 39	80 36 00	400	43	80	75	1.0252	1.027465
11	4.00 p.m.	Hyd. 400	17 42 00	82 34 00	Surface.	80	80	81	1.0252	1.028539
12	9.30 a.m.	Hyd. 405	18 43 09	83 36 45	...do	80	87	80	1.0254	1.028560
12	2.00 p.m.	Hyd. 409	18 54 45	83 53 45	...do	80	85	80	1.0255	1.028660
12	3.20 p.m.	Hyd. 410	19 11 00	84 01 15	...do	78	79	80	1.0256	1.028760
13	11.20 a.m.	Hyd. 413	21 15 45	84 48 00	...do	80	81	80	1.0254	1.028560
13	11.20 a.m.	Hyd. 413	21 15 45	84 48 00	25	78.6	81	80	1.0254	1.028560
13	11.20 a.m.	Hyd. 413	21 15 45	84 48 00	100	73	81	79	1.0260	1.028983
13	11.20 a.m.	Hyd. 413	21 15 45	84 48 00	300	54.8	81	78	1.0254	1.028208
13	11.20 a.m.	Hyd. 413	21 15 45	84 48 00	500	42.3	81	77	1.0250	1.027618
13	11.20 a.m.	Hyd. 413	21 15 45	84 48 00	700	40.3	81	77	1.0250	1.027618
13	11.20 a.m.	Hyd. 413	21 15 45	84 48 00	900	40	81	77	1.0248	1.027418
14	12.00 m.	Hyd. 419	23 48 14	84 06 55	Surface.	80	79	80	1.0254	1.028560
14	....	Hyd. 419	....	....	25	78.6	79	80	1.0254	1.028560
14	....	Hyd. 419	....	....	100	68	79	78	1.0256	1.028408
14	....	Hyd. 419	....	....	300	51.6	79	76	1.0254	1.027832
14	....	Hyd. 419	....	....	500	....	79	76	1.0252	1.027632
14	....	Hyd. 419	....	....	700	40.4	79	76	1.0250	1.027432
14	....	Hyd. 419	....	....	900	....	79	75	1.0252	1.027465
25	4.00 p.m.	....	Key West, Fla.		Surface.	77	80	77	1.0268	1.029418
25	10 00 p.m.	....	....do	....	...do	75	70	77	1.0268	1.029418
26	10.00 a.m.	....	....do	....	...do	77	79	77	1.0266	1.029218
26	5.00 p.m.	....	....do	....	...do	75	74	76	1.0270	1.029432
27	10.00 a.m.	....	....do	....	...do	77	78	77	1.0266	1.029218
27	4.30 p.m.	....	....do	....	...do	76	76	76	1.0272	1.029632
28	12.00 m.	....	Havana, Cuba.		...do	79	79	79	1.0256	1.028583
28	6.00 p.m.	....	....do	....	...do	75	75	75	1.0260	1.028265
30	9.00 a.m.	Dredge 2155	28 10 21	82 22 44	...do	78	78	78	1.0256	1.028408
May 1	3.30 p.m.	Hyd. 420	Off Havana, Cuba.		...do	79	79	79	1.0255	1.028483
2	8.00 a.m.	Hyd. 421	22 04 15	84 59 35	...do	79	78	79	1.0256	1.028583
2	12.20 p.m.	Hyd. 435	20 00 35	85 02 30	...do	79	81	79	1.0252	1.028183
2	6.00 p.m.	Hyd. 451	22 10 50	85 12 00	...do	79	79	79	1.0254	1.028383
3	8.30 a.m.	Hyd. 470	21 52 35	85 00 45	...do	79	80	79	1.0256	1.028583
3	12.00 m.	Hyd. 475	21 52 50	85 13 25	...do	79	79	80	1.0254	1.028560
3	6.00 p.m.	Hyd. 482	21 47 55	85 10 00	...do	79	80	80	1.0256	1.028760
4	9.30 a.m.	Hyd. 496	21 54 45	84 58 40	...do	79	80	79	1.0254	1.028383
4	1.00 p.m.	Hyd. 504	21 59 20	85 08 40	...do	79	81	80	1.0254	1.028560
12	8.00 a.m.	Hyd. 521	30 46 00	78 35 00	...do	79	79	79	1.0260	1.028983
12	12.00 m.	....	31 16 16	78 25 00	...do	79	80	79	1.0260	1.028983
12	8.00 p.m.	....	32 00 00	77 10 00	...do	78	80	79	1.0258	1.028783
13	8.00 a.m.	....	33 00 00	75 45 00	...do	71	70	75	1.0256	1.027865
13	12.00 m.	....	33 21 36	75 16 00	...do	75	72	75	1.0260	1.028265
13	8.00 p.m.	....	34 10 00	77 12 00	...do	72	70	73	1.0264	1.028324
14	7.00 a.m.	....	34 14 00	72 35 30	...do	67	70	69	1.0270	1.028287
14	12.00 m.	....	34 33 03	73 24 30	...do	68	73	70	1.0268	1.028250

A.—*Specific gravities of sea-water*—Continued.

Date.	Time of day.	Station.	Latitude N.	Longitude W.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Reduced to 60° F.
1884.			° ′ ″	° ′ ″		°	°	°		
May 14	8.00 p.m.	....	34 55 00	72 43 00	...do	67	70	69	1.0270	1.028287
15	8.00 a.m.	....	35 37 00	74 24 00	...do	77	63	77	1.0260	1.028618
15	12.00 m.	....	35 53 18	75 04 00	...do ...	54	57	56	1.0256	1.025120
15	8.00 p.m.	....	Off Cape Henry, Va.		...do	61	60	63	1.0200	1.020411
15	10.00 p.m.	....	Willoughby Spit, Va.		...do	61	60	63	1.0150	1.015411
16	12.00 m.	....	Cherrystone River.		...do	60	61	63	1.0130	1.013411
16	6.00 a.m.	....	Piney Point, Md.		...do	61	62	63	1.0070	1.007411
16	7.30 a.m.	....	Blackiston's Island, Md.		...do	61	63	63	1.0050	1.005411
16	9.15 a.m.	....	Lower Cedar Point, Md.		..do	62	64	64	1.0030	1.003548
16	9.45 a.m.	....	Mathias Point, Va.		...do	62	64	64	1.0010	1.001548
16	10.45 a.m.	....	Maryland Point, Md.		...do	63	64	64	1.0000	1.000548
July 19	1.30 p.m.	....	Navy-yard, Norfolk, Va.		Surface.	80	85	82	1.0080	1.011520
19	5.00 p.m.	....	....do............		...do	82	85	84	1.0085	1.012412
20	11.45 a.m.	Dredge 2170	37 57 00	73 53 30	...do	74	75	74	1.0256	1.027686
20	4.00 p.m.	2172	38 01 15	73 44 00	..do	74	76	74	1.0258	1.027886
20	4.00 p.m.	2172	38 01 15	73 44 00	25	58.8	76	70	1.0262	1.027650
20	4.00 p.m	2172	38 01 15	73 44 00	50	55.4	76	65	1.0268	1.027490
20	4.00 p.m.	2172	38 01 15	73 44 00	100	51	76	63	1.0270	1.027411
20	4.00 p.m.	2172	38 01 15	73 44 00	200	45.1	76	62	1.0270	1.027270
20	4.00 p.m.	2172	38 01 15	73 44 00	300	40.7	76	61	1.0272	1.027330
20	4.00 p.m.	2172	38 01 15	73 44 00	400	40	76	61	1.0272	1.027330
21	5.30 a.m.	2173	37 57 00	72 34 00	Surface.	70	69	70	1.0254	1.026850
21	5.30 a.m.	2173	37 57 00	72 34 00	25	53	69	69	1.0262	1.027487
21	5.30 a.m.	2173	37 57 00	72 34 00	50	51.7	69	60	1.0270	1.027000
21	5.30 a.m.	2173	37 57 00	72 34 00	100	51.7	69	59	1.0274	1.027280
21	5.30 a.m.	2173	37 57 00	72 34 00	200	51.7	69	58	1.0273	1.027060
21	5.30 a.m.	2173	37 57 00	72 34 00	300	40	69	57	1.0273	1.026940
21	5.30 a.m.	2173	37 57 00	72 34 00	400	39.7	69	57	1.0273	1.026940
21	5.30 a.m.	2173	37 57 00	72 34 00	500	39.5	69	57	1.0273	1.026940
21	5.30 a.m.	2173	37 57 00	72 34 00	600	38.7	69	57	1.0274	1.027040
21	5.30 a.m.	2173	37 57 00	72 34 00	700	38.7	69	60	1.0271	1.027100
21	5.30 a.m.	2173	37 57 00	72 34 00	900	38.1	69	57	1.0274	1.027040
22	8.30 a.m.	2175	39 33 00	72 18 30	Surface.	68	72	68	1.0244	1.025536
22	8.30 a.m.	2175	39 33 00	72 18 30	25	50.5	72	60	1.0262	1.026200
22	8.30 a.m.	2175	39 33 00	72 18 30	50	51.3	72	60	1.0268	1.026800
22	8.30 a m	2175	39 33 00	72 18 30	100	50.6	72	62	1.0263	1.026570
22	8.30 a.m.	2175	39 33 00	72 18 30	200	44.1	72	59	1.0273	1.027180
23	5.00 p.m.	Hyd. 533	39 23 45	71 43 00	Surface.	69	71	70	1.0250	1.026450
23	5.00 p.m.	Hyd. 533	39 23 45	71 43 00	25	57	71	64	1.0266	1.027148
23	5.00 p.m.	Hyd. 533	39 23 45	71 43 00	50	52.8	71	62	1.0262	1.026470
23	5.00 p.m.	Hyd. 533	39 23 45	71 43 00	100	50.7	71	62	1.0270	1.027270
23	5.00 p.m.	Hyd. 533	39 23 45	71 43 00	200	44.2	71	59	1.0273	1.027180
23	5.00 p.m.	Hyd. 533	39 23 45	71 43 00	300	40.7	71	57	1.0274	1.027040
23	5.00 p.m.	Hyd. 533	39 23 45	71 43 00	400	40.2	71	58	1.0274	1.027160
23	5.00 p.m.	Hyd. 533	39 23 45	71 43 00	500	40	71	59	1.0272	1.027080
23	5.00 p m.	Hyd. 533	39 23 45	71 43 00	600	39.6	71	60	1.0272	1.027200
23	5.00 p m.	Hyd. 533	39 23 45	71 43 00	700	38.7	71	58	1.0274	1.027160
23	5.00 p.m.	Hyd. 533	39 23 45	71 43 00	800	38.7	71	58	1.0275	1.027260
Aug. 2	12.00 m.	....	39 57 49	70 56 30	Surface.	69	70	80	1.0224	1.025560
3	12.00 m.	....	39 50 27	71 08 00	...do	68	69	80	1.0222	1.025360
3	7.00 p.m.	Hyd. 544	39 55 00	71 07 00	...do	68	70	72	1.0240	1.025764
3	7.00 p.m.	Hyd. 544	39 55 00	71 07 00	25	64.3	70	68	1.0256	1.026736
3	7.00 p.m.	Hyd. 544	39 55 00	71 07 00	50	51.8	70	63	1.0262	1.026611
3	7.00 p.m.	Hyd. 544	39 55 00	71 07 00	100	51.8	70	62	1.0268	1.027070
3	7.00 p.m.	Hyd. 544	39 55 00	71 07 00	224	42.3	70	66	1.0265	1.027340
4	11.00 a.m.	Dredge 2190	39 40 00	70 20 15	Surface.	73	73	74	1.0253	1.027386
4	7.15 p.m.	Hyd. 545	39 47 00	70 16 30	...do	72	74	83	1.0236	1.027326
4	7.15 p.m.	Hyd. 545	39 47 00	70 16 30	25	61.1	74	83	1.0240	1.027726
4	7.15 p.m.	Hyd. 545	39 47 00	70 16 30	50	52.6	74	83	1.0240	1.027726
4	7.15 p.m.	Hyd. 545	39 47 00	70 16 30	100	52.2	74	84	1.0240	1.027912
4	7.15 p.m.	Hyd. 545	39 47 00	70 16 30	200	45.9	74	84	1.0236	1.027512
4	7.15 p.m.	Hyd. 545	39 47 00	70 16 30	300	40.9	74	83	1.0238	1.027526
4	7.15 p.m.	Hyd. 545	39 47 00	70 16 30	400	39.6	74	83	1.0238	1.027526
4	7.15 p.m.	Hyd. 545	39 47 00	70 16 30	500	39.3	74	83	1.0237	1.027426
4	7.15 p.m.	Hyd. 545	39 47 00	70 16 30	600	39.2	74	83	1.0238	1.027526
4	7.15 p.m.	Hyd. 545	39 47 00	70 16 30	700	38.9	74	83	1.0236	1.027326
5	7.45 p.m.	Dredge 2195	39 44 00	70 03 00	Surface.	74	76	85	1.0234	1.027500

A.—*Specific gravities of sea-water*—Continued.

Date.	Time of day.	Station.	Latitude N.	Longitude W.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Reduced to 60° F.
1884.			° ′ ″	° ′ ″		°	°	°		
Aug. 6	11.38 a.m.	Dredge 2197	39 56 30	69 43 20	...do	74	78	78	1.0246	1.027408
6	11.38 a.m.	2197	39 56 30	69 43 20	25	49.8	78	78	1.0238	1.026608
6	11.38 a.m.	2197	39 56 30	69 43 20	50	52.8	78	78	1.0244	1.027208
6	11.38 a.m.	2197	39 56 30	59 43 20	79	52.3	78	79	1.0244	1.027383
19	12.00 m.	....	39 37 10	71 43 00	Surface.	73	72	82	1.0243	1.027820
20	7.00 a.m.	Dredge 2205	39 35 00	71 18 45	...do	73	68	81	1.0233	1.026639
20	12.00 m.	....	39 35 33	71 31 45	...do	75	75.5	82	1.0240	1.027520
20	5.13 p.m.	Hyd. 549	39 34 00	71 34 30	...do	74	75	82	1.0240	1.027520
20	5.13 p.m.	Hyd. 549	39 34 00	71 34 30	25	66.1	75	82	1.0242	1.027720
20	5.13 p.m.	Hyd. 549	39 34 00	71 34 30	50	54.8	75	82	1.0243	1.027820
20	5.13 p.m.	Hyd. 549	39 34 00	71 34 30	100	51.2	75	83	1.0239	1.027626
20	5.13 p.m.	Hyd. 549	39 34 00	71 34 30	200	43.8	75	84	1.0235	1.027412
20	5.13 p.m.	Hyd. 549	39 34 00	71 34 30	300	40.6	75	83	1.0237	1.027426
20	5.13 p.m.	Hyd. 549	39 34 00	71 34 30	400	40.1	75	82	1.0238	1.027320
20	5.13 p.m.	Hyd. 549	39 34 00	71 34 30	500	40.6	75	83	1.0236	1.027326
20	5.13 p.m.	Hyd. 549	39 34 00	71 34 30	600	39.2	75	82	1.0237	1.027220
20	5.13 p.m.	Hyd. 549	39 34 00	71 34 30	700	38.5	75	82	1.0237	1.027220
20	5.13 p.m.	Hyd. 549	39 34 00	71 34 30	800	39	75	83	1.0238	1.027526
20	5.13 p.m.	Hyd. 549	39 34 00	71 34 30	925	38.6	75	83	1.0234	1.027126
21	7.00 a.m.	Dredge 2208	39 33 00	71 16 15	Surface.	71	72	84	1.0234	1.027312
21	12.00 m.	....	39 37 37	71 16 15	...do	74	77	83	1.0236	1.027326
22	8.00 a.m.	Dredge 2212	39 59 30	70 30 45	...do	71	74	84.5	1.0230	1.026993
22	11.45 a.m.	2213	39 58 30	70 30 00	...do ...	71	75	85	1.0231	1.027200
22	6.10 p.m.	2216	39 47 00	70 30 30	...do	71	77	83	1.0234	1.027136
23	8.00 a.m.	2217	39 47 20	69 34 15	...do	75	76	86	1.0230	1.027316
23	1.36 p.m.	2219	39 46 22	69 29 00	...do ...	74	74	86	1.0228	1.027116
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	...do ...	75	75	80.5	1.0241	1.027339
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	25	63.2	75	80	1.0246	1.027760
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	50	55.9	75	80.5	1.0246	1.027769
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	100	52.5	75	81	1.0246	1.027939
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	200	44.3	75	81	1.0242	1.027539
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	300	40.7	75	80	1.0243	1.027460
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	400	39.3	75	80	1.0242	1.027360
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	500	40.6	75	80	1.0240	1.027160
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	600	39.2	75	81	1.0238	1.027139
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	700	39.1	75	80	1.0240	1.027160
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	800	38.6	75	79	1.0242	1.027183
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	900	....	75	80	1.0242	1.027360
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	1,000	38.8	75	81.5	1.0240	1.027346
23	8.00 p.m.	Hyd. 552	39 40 05	69 23 00	1,089	38.3	75	80	1.0242	1.027[illegible]60
Sept. 6	9.00 a.m.	Dredge 2221	39 05 30	70 44 30	Surface.	73	74	83	1.0233	1.027026
6	9.00 a.m.	2222	39 03 15	70 50 45	...do	74	79	83.5	1.0230	1.026807
7	7.00 a.m.	2223	37 48 30	69 43 30	...do	81	78	87	1.0234	1.027909
7	7.00 p.m.	Hyd. 553	37 41 00	69 16 15	...do	82	78	86.5	1.0236	1.027999
7	7.00 p.m.	Hyd. 553	37 41 00	69 16 15	25	82	78	87	1.0238	1.028309
7	7.00 p.m.	Hyd. 553	37 41 00	69 16 15	50	79.8	78	87	1.0237	1.028209
7	7.00 p.m.	Hyd. 553	37 41 00	69 16 15	100	72.7	78	88.5	1.0232	1.027988
7	7.00 p.m.	Hyd. 553	37 41 00	69 16 15	200	57.3	78	88	1.0232	1.027904
7	7.00 p.m.	Hyd. 553	37 41 00	69 16 15	300	44	78	87	1.0231	1.027609
7	7.00 p.m.	Hyd. 553	37 41 00	69 16 15	400	45.6	78	86.5	1.0230	1.027399
7	7.00 p.m.	Hyd. 553	37 41 00	69 16 15	500	40.5	78	86.5	1.0229	1.027299
7	7.00 p.m.	Hyd. 553	37 41 00	69 16 15	600	39.6	78	88	1.0228	1.027504
7	7.00 p.m.	Hyd. 553	37 41 00	69 16 15	700	39.6	78	87	1.0228	1.027309
7	7.00 p.m.	Hyd. 553	37 41 00	69 16 15	800	39.5	78	86.5	1.0230	1.027399
7	7.00 p.m.	Hyd. 553	37 41 00	69 16 15	900	39	78	86.5	1.0232	1.027599
7	7.00 p.m.	Hyd. 553	37 41 00	69 16 15	1,000	38.6	78	86.5	1.0235	1.027899
8	8.00 p.m.	Dredge 2224	36 16 30	68 21 00	Surface.	80	80	86	1.0240	1.028316
8	8.00 p.m.	2224	36 16 30	68 21 00	25	79.8	80	86	1.0238	1.028116
8	8.00 p.m.	2224	36 16 30	68 21 00	50	77.1	80	86	1.0238	1.028116
8	8.00 p.m.	2224	36 16 30	68 21 00	100	67.1	80	87.5	1.0236	1.028119
8	8.00 p.m.	2224	36 16 30	68 21 00	200	64.8	80	87.5	1.0236	1.028119
8	8.00 p.m.	2224	36 16 30	68 21 00	300	64.6	80	86	1.0238	1.028116
8	8.00 p.m.	2224	36 16 30	68 21 00	400	63.8	80	86	1.0237	1.028016
8	8.00 p.m.	2224	36 16 30	68 21 00	500	52.5	80	85.5	1.0238	1.027982
8	8.00 p.m.	2224	36 16 30	68 21 00	600	41.9	80	87	1.0228	1.027309
8	8.00 p.m.	2224	36 16 30	68 21 00	700	41	80	86	1.0229	1.027216
8	8.00 p.m.	2224	36 16 30	68 21 00	800	40.2	80	86	1.0230	1.027316
8	8.00 p.m.	2224	36 16 30	68 21 00	900	39.5	80	86	1.0238	1.028116
8	8.00 p.m.	2224	36 16 30	68 21 00	1,000	39.5	80	86.5	1.0238	1.028199
9	4.00 p.m.	2225	36 05 30	69 51 45	Surface.	81	82	80	1.0250	1.028160
9	4.00 p.m.	2225	36 05 30	69 51 45	25	78.8	82	80	1.0250	1.028160
9	4.00 p.m.	2225	36 05 30	69 51 45	50	71.9	82	79.5	1.0251	1.028161

A.—*Specific gravities of sea-water*—Continued.

Date.	Time of day.	Station.	Latitude N.	Longitude W.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Reduced to 60° F.
1884.			° ′ ″	° ′ ″		°	°	°		
Sept. 9	4.00 p.m.	Dredge 2225	36 05 30	69 51 45	100	67.6	82	80	1.0253	1.028460
9	4.00 p.m.	2225	36 05 30	69 51 45	200	64.7	82	80	1.0252	1.028360
9	4.00 p.m.	2225	36 05 30	69 51 45	300	64.8	82	79	1.0254	1.028383
9	4.00 p.m.	2225	36 05 30	69 51 45	400	60	82	79	1.0249	1.027883
9	4.00 p.m.	2225	36 05 30	69 51 45	500	51.1	82	79	1.0244	1.027383
9	4.00 p.m.	2225	36 05 30	69 51 45	600	44.7	82	80	1.0242	1.027360
9	4.00 p.m.	2225	36 05 30	69 51 45	700	41.4	82	79.5	1.0252	1.028261
9	4.00 p.m.	2225	36 05 30	69 51 45	800	40.2	82	80	1.0245	1.027660
9	4.00 p.m.	2225	36 05 30	69 51 45	900	39.6	82	80	1.0240	1.027160
9	4.00 p.m.	2225	36 05 30	69 51 45	1,000	39.2	82	80	1.0244	1.027560
10	7.00 p.m.	2227	36 55 23	71 55 00	Surface.	81	81	80	1.0253	1.028460
10	7.00 p.m.	2227	36 55 23	71 55 00	25	82.2	81	80	1.0252	1.028360
10	7.00 p.m.	2227	36 55 23	71 55 00	50	77.1	81	80	1.0252	1.028360
10	7.00 p.m.	2227	36 55 23	71 55 00	100	71.4	81	80	1.0254	1.028560
10	7.00 p.m.	2227	36 55 23	71 55 00	200	65.2	81	79.5	1.0252	1.028261
10	7.00 p.m.	2227	36 55 23	71 55 00	300	62.8	81	79.5	1.0252	1.028261
10	7.00 p.m.	2227	36 55 23	71 55 00	400	57.7	81	79.5	1.0254	1.028461
10	7.00 p.m.	2227	36 55 23	71 55 00	500	54.7	81	79.5	1.0242	1.027261
10	7.00 p.m.	2227	36 55 23	71 55 00	600	42.5	81	79.5	1.0242	1.027261
10	7.00 p.m.	2227	36 55 23	71 55 00	700	40.4	81	79	1.0242	1.027183
10	7.00 p.m.	2227	36 55 23	71 55 00	800	39.3	81	79.5	1.0240	1.027061
10	7.00 p.m.	2227	36 55 23	71 55 00	900	39.2	81	80	1.0242	1.027360
10	7.00 p.m.	2227	36 55 23	71 55 00	1,000	39.1	81	80	1.0244	1.027560
11	2.00 p.m.	Hyd. 554	37 22 53	73 06 30	Surface.	79	80	79	1.0226	1.025583
11	2.00 p.m.	Hyd. 554	37 22 53	73 06 30	25	76	80	78.5	1.0246	1.027486
11	2.00 p.m.	Hyd. 554	37 22 53	73 06 30	50	63.2	80	77.5	1.0250	1.027695
11	2.00 p.m.	Hyd. 554	37 22 53	73 06 30	100	63.8	80	77	1.0249	1.027518
11	2.00 p.m.	Hyd. 554	37 22 53	73 06 30	200	48	80	77	1.0248	1.027418
11	2.00 p.m.	Hyd. 554	37 22 53	73 06 30	300	40.3	80	76	1.0247	1.027132
11	2.00 p.m.	Hyd. 554	37 22 53	73 06 30	400	39.7	80	76.5	1.0244	1.026908
11	2.00 p.m.	Hyd. 554	37 22 53	73 06 30	500	39.4	80	76.5	1.0244	1.026908
11	2.00 p.m.	Hyd. 554	37 22 53	73 06 30	600	39.3	80	77	1.0244	1.027018
11	2.00 p.m.	Hyd. 554	37 22 53	73 06 30	700	39.1	80	76.5	1.0248	1.027308
11	2.00 p.m.	Hyd. 554	37 22 53	73 06 30	800	38.8	80	76.5	1.0248	1.027308
11	2.00 p.m.	Hyd. 554	37 22 53	73 06 30	900	....	80	76	1.0246	1.027032
11	2.00 p.m.	Hyd. 554	37 22 53	73 06 30	1,000	38.7	80	76.5	1.0246	1.027108
12	7.00 p.m.	Hyd. 556	39 40 00	73 03 00	Surface.	76	70	71	1.0234	1.025006
12	7.00 p.m.	Hyd. 556	39 40 00	73 03 00	25	61.8	70	71	1.0244	1.026006
12	7.00 p.m.	Hyd. 556	39 40 00	73 03 00	50	52.4	70	71.5	1.0250	1.026679
12	7.00 p.m.	Hyd. 556	39 40 00	73 03 00	100	49.3	70	71	1.0256	1.027206
12	7.00 p.m.	Hyd. 556	39 40 00	73 03 00	200	43.5	70	71.5	1.0254	1.027079
12	7.00 p.m.	Hyd. 556	39 40 00	73 03 00	300	40.4	70	71.5	1.0252	1.026879
13	7.00 p.m.	Hyd. 557	39 08 30	72 12 30	Surface.	72	65	78	1.0234	1.026208
13	7.00 p.m.	Hyd. 557	39 08 30	72 12 30	25	65.8	65	77.5	1.0244	1.027095
13	7.00 p.m.	Hyd. 557	39 08 30	72 12 30	50	61.8	65	78	1.0235	1.026308
13	7.00 p.m.	Hyd. 557	39 08 30	72 12 30	100	53.5	65	78.5	1.0234	1.026286
13	7.00 p.m.	Hyd. 557	39 08 30	72 12 30	200	43.1	65	78.5	1.0234	1.026286
13	7.00 p.m.	Hyd. 557	39 08 30	72 12 30	300	40.6	65	77.5	1.0243	1.026995
13	7.00 p.m.	Hyd. 557	39 08 30	72 12 30	400	39.7	65	77	1.0244	1.027018
13	7.00 p.m.	Hyd. 557	39 08 30	72 12 30	500	39.2	65	77	1.0244	1.027018
13	7.00 p.m.	Hyd. 557	39 08 30	72 12 30	600	39.1	65	78	1.0242	1.027008
13	7.00 p.m.	Hyd. 557	39 08 30	72 12 30	700	38.7	65	77.5	1.0243	1.026995
28	9.54 a.m.	Dredge 2259	40 19 30	69 29 10	Surface.	61	67	80	1.0226	1.025760
28	12.50 p.m.	2261	40 04 00	69 29 30	...do	66	69	80	1.0233	1.026460
28	2.51 p.m.	2262	39 54 45	69 29 45	...do	66	75	78	1.0230	1.025883
Oct. 18	1.10 p.m.	2263	37 08 00	74 33 00	...do	66	68	80	1.0226	1.025766
19	8.18 a.m.	2268	35 10 40	75 06 10	...do	69	67	82	1.0220	1.025520
19	12.00 m.	2273	35 20 30	75 17 30	...do	72	68	81	1.0224	1.025739
19	5.16 p.m.	2282	35 21 10	75 22 40	...do	69	67.5	81	1.0226	1.025939
20	9.36 a.m.	2292	35 27 20	75 16 30	...do	71	71	85	1.0212	1.025300
20	12.00 m.	....	35 32 41	75 04 30	...do	72	76.5	85	1.0220	1.026100
20	5.30 p.m.	2300	35 41 30	74 48 30	...do	71	71.5	85	1.0218	1.025900
21	8.45 a.m.	2305	35 23 00	74 51 30	...do	69	77	84	1.0220	1.025912
21	5.30 p.m.	2308	35 43 00	74 53 30	...do	70	72	84	1.0220	1.025912
22	6.00 a.m.	Cape Henry, Virginia.			...do	60	61	84	1.0168	1.020712
22	1.25 p.m.	Point Lookout, Maryland.			...do	65	73	83	1.0106	1.014326
22	2.50 p.m.	Blackiston's Island, Maryland.			...do	65.5	75	81	1.0075	1.010839
22	5.00 p.m.	Upper Cedar Point, Maryland.			...do	65	74.5	79	1.0044	1.007383
22	6.00 p.m.	Maryland Point, Maryland.			...do	64	64	74	1.0034	1.005486
23	7.30 a.m.	Quantico, Virginia.			..do	62	51	63	1.0008	1.000491

B.—*Experiments with the optical densimeter with distilled water.*

[Value of micrometer divisions .00007026.]

Date.	Corrected temperature.	Micrometer reading.	Micrometer reading reduced.	Date.	Corrected temperature.	Micrometer reading.	Micrometer reading reduced.
	°				°		
Aug. 15	67.3	312	330.9	Sept. 6	82.8	260	328.9
17	79	273	328.5	7	89.2	230	324
18	75.9	285.5	330.5	8	90	230	326.7
19	82.7	260.5	329.1	9	90.5	220	318.8
20	84.1	256	329.8	9	85.8	239	319.2
20	76.3	285	331.3	9	90.7	220	319.6
21	76.6	282.5	329.8	10	89.7	229	324.5
28	80	273	332	11	80.7	263	324.3
28	71.1	302	331.9	11	79.5	265	322.2
29	82.8	264	333	12	83.2	254.5	325.7
30	83.4	260	331.2	14	83	262	331.7
Sept. 3	71.4	301	331.8				

C.—*Record of specific gravities determined by the optical densimeter compared with those obtained with the salinometer.*

[The constant for distilled water was determined before each series of observations.]

Date.	Station.	Latitude N.			Longitude W.			Depth.	Specific gravity at 60° by densimeter.	Specific gravity reduced to 60° F. by salinometer.
1884.		°	′	″	°	′	″			
September 6	Dredge 2221	39	05	30	70	44	30	Surface.	1.026383	1.027026
September 6	2222	39	03	15	70	50	45	....do	1.026087	1.026807
September 7	2223	37	48	30	69	43	30	.. do	1.027562	1.027909
September 7	Hyd. 553	37	41	00	69	16	15	....do	1.027394	1.027999
September 7	Hyd. 553	37	41	00	69	16	15	25	1.027745	1.028309
September 7	Hyd. 553	37	41	00	69	16	15	50	1.027759	1.028209
September 7	Hyd. 553	37	41	00	69	16	15	100	1.028539	1.027988
September 7	Hyd. 553	37	41	00	69	16	15	200	1.027696	1.027904
September 7	Hyd. 553	37	41	00	69	16	15	300	1.027232	1.027609
September 7	Hyd. 553	37	41	00	69	16	15	400	1.026902	1.027399
September 7	Hyd. 553	37	41	00	69	16	15	500	1.026916	1.027299
September 7	Hyd. 553	37	41	00	69	16	15	600	1.026944	1.027504
September 7	Hyd. 553	37	41	00	69	16	15	700	1.026829	1.027309
September 7	Hyd. 553	37	41	00	69	16	15	800	1.026853	1.027399
September 7	Hyd. 553	37	41	00	69	16	15	900	1.026965	1.027599
September 7	Hyd. 553	37	41	00	69	16	15	1000	1.027696	1.027899
September 8	Dredge 2224	36	16	30	68	21	00	Surface.	1.027626	1.028316
September 8	2224	36	16	30	68	21	00	25	1.028002	1.028116
September 8	2224	36	16	30	68	21	00	50	1.028209	1.028116
September 8	2224	36	16	30	68	21	00	100	1.028707	1.028119
September 8	2224	36	16	30	68	21	00	200	1.028434	1.028119
September 8	2224	36	16	30	68	21	00	300	1.027991	1 028116
September 8	2224	36	16	30	68	21	00	400	1.027703	1.028016
September 8	2224	36	16	30	68	21	00	500	1.027527	1.027982
September 8	2224	36	16	30	68	21	00	600	1.026811	1.027309
September 8	2224	36	16	30	68	21	00	700	1.027260	1.027216
September 8	2224	36	16	30	68	21	00	800	1.026958	1.027316
September 8	2224	36	16	30	68	21	00	900	1.027837	1.028116
September 8	2224	36	16	30	68	21	00	1000	1.028054	1.028199
September 9	2225	36	05	30	69	51	45	Surface.	1.027766	1.028160
September 9	2225	36	05	30	69	51	45	25	1.027981	1.028160
September 9	2225	36	05	30	69	51	45	50	1.027963	1.028161
September 9	2225	36	05	30	69	51	45	100	1.028005	1.028460
September 9	2225	36	05	30	69	51	45	200	1.027654	1.028360
September 9	2225	36	05	30	69	51	45	300	1.027822	1.028383
September 9	2225	36	05	30	69	51	45	400	1.027654	1.027883
September 9	2225	36	05	30	69	51	45	500	1.027162	1.027883
September 9	2225	36	05	30	69	51	45	600	1.027134	1.027360
September 9	2225	36	05	30	69	51	45	700	1.028216	1.028261
September 9	2225	36	05	30	69	51	45	800	1.027162	1.027660
September 9	2225	36	05	30	69	51	45	900	1.027190	1.027160
September 9	2225	36	05	30	69	51	45	1000	1.027148	1.027560

C.—*Record of specific gravities determined by the optical densimeter, &c.*—Continued.

Date.	Station.	Latitude N.			Longitude W.			Depth.	Specific gravity at 60° by densimeter.	Specific gravity reduced to 60° F. by salinometer.
1884.		°	′	″	°	′	″			
September 10	Dredge 2227	36	55	23	71	55	00	Surface.	1.028075	1.028460
September 10	2227	36	55	23	71	55	00	25	1.027977	1.028360
September 10	2227	36	55	23	71	55	00	50	1.028047	1.028360
September 10	2227	36	55	23	71	55	00	100	1.028258	1.028560
September 10	2227	36	55	23	71	55	00	200	1.027986	1.028261
September 10	2227	36	55	23	71	55	00	300	1.028160	1.028261
September 10	2227	36	55	23	71	55	00	400	1.028314	1.028461
September 10	2227	36	55	23	71	55	00	500	1.027260	1.027261
September 10	2227	36	55	23	71	55	00	600	1.027155	1.027261
September 10	2227	36	55	23	71	55	00	700	1.027196	1.027183
September 10	2227	36	55	23	71	55	00	800	1.027085	1.027061
September 10	2227	36	55	23	71	55	00	900	1.027036	1.027360
September 10	2227	36	55	23	71	55	00	1,000	1.027096	1.027560
September 11	Hyd. 554	37	22	53	73	06	30	Surface.	1.025377	1.025583
September 11	554	37	22	53	73	06	30	25	1.027030	1.027486
September 11	554	37	22	53	73	06	30	50	1.027759	1.027695
September 11	554	37	22	53	73	06	30	100	1.027478	1.027518
September 11	554	37	22	53	73	06	30	200	1.027689	1.027418
September 11	554	37	22	53	73	06	30	300	1.027014	1.027132
September 11	554	37	22	53	73	06	30	400	1.026860	1.026908
September 11	554	37	22	53	73	06	30	500	1.027141	1.026908
September 11	554	37	22	53	73	06	30	600	1.027211	1.027018
September 11	554	37	22	53	73	06	30	700	1.027141	1.027308
September 11	554	37	22	53	73	06	30	800	1.027211	1.027308
September 11	554	37	22	53	73	06	30	900	1.026930	1.027032
September 11	554	37	22	53	73	06	30	1,000	1.026930	1.027108
September 12	556	39	40	00	73	03	00	Surface.	1.024457	1.025006
September 12	556	39	40	00	73	03	00	25	1.026242	1.026006
September 12	556	39	40	00	73	03	00	50	1.026523	1.026679
September 12	556	39	40	00	73	03	00	100	1.027225	1.027206
September 12	556	39	40	00	73	03	00	200	1.027000	1.027079
September 12	556	39	40	00	73	03	00	300	1.026944	1.026879
September 13	557	39	08	30	72	12	30	Surface.	1.026066	1.026208
September 13	557	39	08	30	72	12	30	25	1.026874	1.027095
September 13	557	39	08	30	72	12	30	50	1.026171	1.026308
September 13	557	39	08	30	72	12	30	100	1.026150	1.026286
September 13	557	39	08	30	72	12	30	200	1.026361	1.026286
September 13	557	39	08	30	72	12	30	300	1.027014	1.026995
September 13	557	39	08	30	72	12	30	400	1.026144	1.027018
September 13	557	39	08	30	72	12	30	500	1.026670	1.027018
September 13	557	39	08	30	72	12	30	600	1.026951	1.027008
September 13	557	39	08	30	72	12	30	700	1.027014	1.026995

REPORT OF THE NATURALIST, MR. JAMES E. BENEDICT.

The work of the Albatross for the year 1884 began with a long cruise among the West India Islands and in the Caribbean Sea, under the direction of the Bureau of Navigation, Navy Department. A series of soundings and various observations was to be made for this Bureau, which were necessarily to take precedence of zoological work. However, opportunities were to be given for collecting while the ship was in port, and some dredgings were to be made at sea.

The cruise began on the 10th of January, when the Albatross sailed from Norfolk, Va., for St. Thomas, where the anchor was dropped at about noon on the 17th in the harbor of Charlotte Amalie. The island seemed very beautiful to those of us who saw a tropical country for the

first time. The red roofs of the town, as it extended up the side of the hill, where deep gullies divide its upper edge into three sections, make a fine contrast with the water on the one side, and the green shrubs, which densely cover the hill rising high above it, on the other.

St. Thomas lies nearly east and west, and is about 12 miles in length by from 2 to 3 in width. A range of steep hills extends its entire length. The proportion of anything like level ground is inconsiderable. In many places the shore is bold and jagged; in others it slopes down gently to the water's edge. Here and there an indentation in the shore-line affords protection to animal life from the force of the waves. Towards the eastern end of the island is a large lagoon, with shores and islands lined with mangrove trees. The roots and stolons of these trees are covered with sponges, ascidians, oysters, and aquatic plants. These in turn afford a hidingplace for worms, crabs, and many other free swimming animals. The hills are covered with small trees and shrubs, often interspersed with large cactus plants of several species, making the thicket difficult to penetrate in some localities.

In the afternoon of the first day we began to collect, and continued this every day until the ship sailed. We found no mammals, and were informed that with the exception of a small rodent no mammals were indigenous to the island. I take it for granted, however, that exception should also be made to one or more species of bats, though we did not see any.

Birds were not numerous, only thirty-five specimens being taken during our stay, representing ten species, identified by Mr. Ridgway as follows:

Mimus gilvus, Vieill.
Dendroica petechia (Linn.).
Certhiola portoricensis, Bryant.
Phonipara zena (Linn.).
Icterus vulgaris, Daud.
Tyrannus dominicensis (Gm.).
Crotophaga ani, Linn.
Coccyzus minor (Gmel.).
Tinnunculus caribæarum (Gm.).
Chamæpelia passerina (Linn.).

Twenty-five skins were made, the remainder being preserved in alcohol.

The only snake obtained was brought on board alive by one of the sailors, it being harmless, as all of the reptiles on the island are said to be.

Lizards were very plentiful, and several species were taken. One species of rather small size was abundant on trees and fences, and were easily obtained by the small boys, who sometimes accompanied us a short distance on our excursions, by means of a blade of tough grass, the end of which they skilfully formed into a noose. The lizards watch the slow movements by which this is put over their heads with great curiosity, and only realize what is going on when they dangle in the air or are being placed in a jar of alcohol. I found a very small wire much better than a blade of grass for my use. It seemed impossible to capture the much larger ground lizards in this way, as upon seeing any one

they ran about uneasily, suspicious of every movement. I made use of a charge of dust shot in a 32-caliber shell, with good effect, not materially injuring the specimens.

Insect life was not abundant, owing perhaps to the season of the year, though I should think that the large numbers of lizards served somewhat to keep them down. Spiders and centipedes were preserved whenever secured.

Fish are taken by the fishermen in wicker-baskets, made and used on the same principle as our lobster-traps. I was informed that the greater supply of the fish in the market was obtained by means of these traps, though some fish are caught by still-baiting with hook and line and by trolling in the lagoon. I saw a fish-basket taken up which contained a number of highly-colored fish, and from which I obtained a fair selection for the Commission. One of these baskets was obtained for the National Museum.

We collected some interesting crustaceans; one, a small squill, which lives in cavities under stones and corals, where it fastens its eggs and stands guard over them. One species of crab is found everywhere along the shore, running out of the water and resting on the rocks. Mr. Nye found that he could catch one only by running up as a wave dashed over it, and landing it with a scoop-net in some open place before it could climb out of the net, which it does with surprising agility. These crabs run without apparent difficulty up the perpendicular sides of a rock.

We made it a rule to save the smaller fishes, mollusks, crustaceans, worms, &c., in large numbers whenever they could be obtained, in the hope of finding something new or rare, especially as our very limited time did not permit us to discriminate closely. Some dredgings were made at the entrance of the harbor and a little way outside, with a small boat-dredge, which we put over from the dinghy in tow of the captain's gig. This was hard work; but the additional specimens obtained well repaid us for the trouble. We were very kindly treated by the people of St. Thomas, and, through the courtesy of Baron Eggers, we were allowed to shoot on his land, it being against the law to shoot indiscriminately in the highways and woodlands.

On January 24 we left St. Thomas and stood out to sea on a southerly course. The first soundings in the Caribbean Sea were made in sight of St. Thomas. Here and elsewhere during the cruise, when the water was deep enough to necessitate the use of a sounding-shot, the sounding-cup would, as a rule, come up filled with ooze. This was carefully labeled and put into bottles, sometimes as it came up and sometimes after having been washed; only the foraminifera, pteropod shells, and sponge spicules being saved, as each seemed to require.

The color of the ooze brought up from the deep water of the Caribbean Sea is very much lighter than that from a similar depth in the Atlantic Ocean off our eastern coast. This is no doubt the natural result of the shores being largely made up of coral formations. It is well known

that in some of the shallow bays a violent wind will stir up the bottom until the water is almost milk-white with particles of coral. We found the proportion of foraminifera in the ooze to be large. As was to be expected, a greater number of these belonged to the genus *Globigerina*. *G. rubra* was conspicuous.

Pteropod shells in many localities were very numerous, much to our surprise, as I do not remember having seen a single shell of this group taken in the sounding-cup in the Atlantic, and but comparatively few in the dredgings. We saw the explanation of the number of these shells on the bottom when near Trinidad, where for some distance we steamed through water alive with them. A large number were caught in a scoop-net and were found to belong to the genus *Styliola*.

On January 27 the large beam-trawl was put over in 683 fathoms, Station No. 2117, being the first haul in the Caribbean Sea, and a very successful one. Among the things brought up were several forms of coral, one of them a beautiful cup coral of a species new to our collections; also many shells related to the pectens. These shells were very thin and transparent, showing the animal quite distinctly. Echinoderms were represented by starfish, brittle-stars, sea-urchins, and sea-cucumbers. Sponges, both siliceous and horny, worm-tubes with long glass spicules attached, and many small crustaceans, &c., made up the material in the trawl-net. The mud-bag, which was attached to the end of the trawl-net, was nearly filled with ooze, which yielded a large percentage of foraminifera. This foraminifera is in better condition than any we have before saved in quantity, as the coral ooze from which it was washed leaves the shells clean and perfect.

On January 28, one haul was made with the large beam-trawl, Station No. 2118, in 690 fathoms. The water deepened so rapidly that no bottom specimens were brought up. However, several interesting crustaceans were taken from the wing-nets. At Station 2119, on January 29, in 1,140 fathoms, the trawl was lost. Station 2120 in 73 fathoms, January 30, the dredge was put over, but only a small amount of material was taken.

The Albatross came to anchor in the harbor of Port of Spain, Trinidad, late in the afternoon of January 30. After dark the electric light was used to collect surface specimens. A gill-net was set near the ship without result. The next day the collectors went along the shore in different directions, in order to cover as much ground as possible during our very short stay. The water is very shallow along the shore, on either side of the town. The bottom is a soft mud, in which grows quantities of eel-grass. On the shore, just out of reach of an ordinary tide, is a low bank filled with the burrows of crabs. We dug out some of these, and sifted a good deal of sand and mud from high-water mark to as far out as we could wade, for shells, crustaceans, and worms. While we were collecting in this way, Captain Tanner obtained information which led to the successful hunting of the remarkable guacharo bird

(*Steatornis caripensis*). This bird is commonly known as "fruit eating hawk," "fat-bird," "oil-bird," "cave-bird," and in Spanish, guacharo bird.

At half past 7 on the morning of February 1, Captain Tanner and four members of the scientific staff left the ship, in the steam-launch for Mono Island, 10 miles distant, and near where the birds we were in search of live in caves. When nearly there, Mr. Garrett and Mr. Ackerman were left on a small island to collect until the return of the launch. The others kept on to Mono Island, where the captain found Mr. Morrison, to whom he had been directed as the best guide to the caves. Mr. Morrison consented to go with us in search of the birds, and also offered to show us where we could shoot a peculiar bat, known as the "fishing-bat." Under his guidance we steamed around to the western side of the island, where the shore is formed by a huge and nearly perpendicular wall of rock many feet high. Several of us went in a small boat to as near the cliff as was safe, when Mr. Morrison pointed out a fissure in which the bats lived. According to his direction, several charges of shot were fired into the fissure, when the bats literally swarmed out. Mr. Nye was in readiness, and killed a number, only six of which were picked up, the others falling nearer the cliff than it was safe to go, as the waves were dashing up against it with considerable force. Those we did get were put into alcohol, a supply of which was brought with us in the launch. These bats are large, having an expanse of from 22 to 24 inches from tip to tip. We saw them afterward in the evening flying slowly along close to the water. They are said to catch fish with the sharp claws of the hind limbs, aided by the membrane between them, which is very full. I examined the contents of the stomach of one of these animals and found, by the aid of a microscope, the scales of fish and also the scales from the wings of lepidopterus insects. The stomach contained but little, as they were killed some hours after their feeding time. From this place we steamed around the island to Trinidad, and tried to enter a cave there, inhabited by the guacharo birds. The larger caves on Huevos Island were then too much exposed to the ocean to be accessible, and at any season can be approached only on occasional days, when the water is very smooth.

We found the cave on the western side of Trinidad too much exposed to enter with anything like safety, though several attempts were made. We were finally obliged to give it up, to our great disappointment. The entire floor of the cave is water. As a swell advances inward, innocent at first, it becomes angry and dangerous long before it reaches the farther end, where it brings up with a heavy booming sound, leaving jagged rocks briefly exposed in its wake. The entrance to the chamber where the birds live is about 10 feet high, 12 feet wide at the bottom, and 50 feet long. The chamber is about 40 feet in diameter at its base and 35 feet high. A colored man was employed to take us in in his canoe. Mr. Morrison assisted in the management of it, while Mr.

Nye and myself held our guns in readiness. We were backed in about 35 feet when a breaker boarded us, half filling the canoe with water, and we came out as soon as possible. The canoe being too heavily loaded, I got out, and the others went in again. This time Mr. Nye succeeded in shooting two birds, but before he could secure them another breaker boarded them and again partly filled the boat. The swells becoming heavier, we considered it unsafe to venture into the cave again; however, being very desirous of obtaining the birds, we adopted another plan, which was to shoot them as they came out at night. Captain Tanner thought well of this, and went back to the ship, leaving Mr. Nye and myself to carry out the plan, with Mr. Morrison's assistance, at whose house the greater part of the afternoon was pleasantly spent. Towards night we went into a grove of cocoanut-palms and killed a number of birds. Before dark we were again at the cave in a canoe. Mr. Nye landed and obtained as good a position as the nature of the ground would allow, while I remained in the boat near the cave to shoot as best I could against the face of the precipitous hill which rises above it. The birds did not come out until after dark, when it was possible to see them only against the sky. Nevertheless, Mr. Nye killed two, only one of which was recovered, and that after it had been in the water for half an hour. The night was passed at Mr. Morrison's house, where we were treated to the novel sensation of having a light burn all night as a protection against the bites of small bats which were liable to enter.

Early in the morning we left for Port of Spain on a small steamboat running between Mono Island and that place. In the evening of the same day the Albatross anchored in a harbor of Mono Island. Mr. Nye landed as before, and killed several birds, only one, however, being recovered. The skins of both birds are in good condition for mounting and the bodies are preserved in alcohol. When the heads were reached in the operation of skinning a large number of parasites were found under the eyelids.

The list of birds from Trinidad and vicinity, as made out by Mr. Ridgway, is as follows:

Certhiola luteola, Licht.	*Diplopterus nævius* (Gm.).
Tanagra sclateri, Berlepsch.	*Engyptila verreauxi* (Bps.).
Tanagra palmarum (Max.).	*Pelecanus fuscus* (Linn.).
Tachyphonus melaleucus (Sparrm.).	*Fregata aquila* (Lin.).
Tyrannus melancholicus, Vieill.	*Sula leucogastra* (Bodd.).
Contopus brachytarsus, Scl.	*Sula piscator* (Linn.).
Thamnophilus atricapillus (Gm.).	*Sterna maxima* (Bodd.).

Late at night the electric light was put over, and among other things a small squid was captured.

We put to sea from Mono Island on February 3. Two hauls were made during the day. Station 2121, in 31 fathoms, taking a small

amount of material. The bottom was mud and unsuitable for a large variety of animals. Among the shrimp-like forms Prof. S. I. Smith made out the following: *Parapenæus politus*, *P. constrictus*, and *Solenocera siphonocera*. Station 2122, in 34 fathoms, taking a fine Astrophyton, shells, crabs, and *Parapenæus politus* again.

The Albatross came to anchor in Santa Ana harbor, Curaçao, on the 10th of February. Curaçao is about 40 miles in length and 10 in width. The surface is hilly, and with the exception of the mangrove trees on the southwestern side of the islands in the harbor, almost no trees are to be seen. Exposed rocks and ledges show fossil shells and corals in abundance. Large rocks on the shores in the harbor are eroded on all sides by the water, and look as if they were standing on narrow pedicels ready to topple over. The wind blows from the northeast the greater part of the year, and keeps the water more or less rough. On the windward shores the waves erode the lower parts of the banks until the banks project over the water and often break off. On this side also the bottom for some distance from the shore is hard and rocky, while the leeward side is muddy, and the shore is lined with mangroves. One of the most interesting features of these islands are the pits excavated by men from the town getting sand for building material. In these places a large number of fossil corals and shells are strewn about. Small bushes near the water are often covered with land shells of the family *Pupidæ*.

Birds are not abundant in the part of the island where we were, which is due in part, perhaps, to the lack of trees. On our collecting excursions we often carried guns, and some birds were collected, though no especial effort was made to do so. The following is a list of the species taken, four of which have been described as new by Mr. Ridgway in the Proceedings of the National Museum:

Mimus gilvus rostratus, Ridgw.	*Zenaida vinacco-rufa*, Ridgw.
Dendroica rufopileata, Ridgw.	*Chamæpelia passerina* (Lin.).
Icterus curasoënsis, Ridgw.	*Ardea herodias* (Lin.).

The boat-dredge was used in the harbor with little or no success, as either it came up filled with a soft mud, in which little or nothing lives, or it was caught as soon as it reached the bottom. We also tried to use it outside of the harbor, but with the same result, except that when it was not caught on the bottom it came up filled with coral sand. We found it greatly to our advantage to have a guide acquainted with the different localities. On one occasion this man bought for ten cents all of the small fish and crustaceans from several hauls of a large seine. I hired a man to make several large torches for night-collecting around the shores of the island, and with the guide and two colored men, who volunteered to go with us, set out at night for the island. We captured several fish and crabs, but the principal catch was the octopus, or "sea-cat," as it is called here. Fifteen specimens were taken during the

evening and put into alcohol, which we always carried with us on our excursions. One of the crabs was the large *Cardiosoma*, so common in the West Indies. Large sponges were often seen, but we had no means of preserving them. One sponge, not far from the shore, was seen to cause the water at the surface, some 18 inches above it, to boil up with some force. This was rolled ashore and cut up for the crustaceans, which were to be found living in the large canals. This sponge was not less than three feet through and nearly spherical. Coral was abundant, but we could preserve only the small specimens. Large specimens can be preserved to advantage only when they can be left in the sun to dry until dead and then put in water until the animal matter is dissolved out. This takes time, and our stay would not permit it. Lizards of larger size than those taken at St. Thomas were shot. Our guides caught small ones and brought us stones with their eggs attached to the under surface.

The Albatross sailed from Curaçao on the 18th of February. On the same day two hauls were made: Station 2124, in 122 fathoms, with the dredge, taking but little material; and Station 2125, in 208 fathoms, with the small beam-trawl, taking a number of sponges, echinoderms, and a new shrimp-like crustacean, since described by Prof. S. I. Smith in the Proceedings of the National Museum as *Hymenopenæus robustus*.

The haul at Station 2126, in 1,701 fathoms, February 19, was moderately successful in the amount of material taken; Station 2127, on February 25, in 1,639 fathoms, taking an interesting octopus and a few other things. Although in these hauls the amount of material taken was small, the forms were very different from any we had before dredged, making them in reality of considerable value.

On the 26th of February the Albatross came to anchor in the harbor of Santiago de Cuba, and remained there until the next day. No shore collecting was done. On the 27th eight hauls were made with the tangle in sight of the entrance to the harbor of Santiago de Cuba. Stations 2128 to 2135, inclusive, the depth of water ranging from 175 to 400 fathoms. Four or five large specimens of a crinoid (*Pentacrinus*) were taken in water from 250 to 290 fathoms. In addition to these we obtained many other echinoderms, corals, crabs, and shrimp. On the 29th three hauls were made on a bank to the eastward of Jamaica, Stations 2136–2138, inclusive, in 52, 47, and 23 fathoms, respectively.

We arrived in Kingston, Jamaica, March 1. At this place we made large collections. With a small seine, made of mosquito netting, we took many small fish and crustaceans. Larger fish were bought of the fishermen for small sums. Three specimens of a large crustacean, *Scyllarus æquinoxialis*, were bought of fishermen who had taken them in fish-baskets in from 25 to 40 fathoms. This animal is known as the "sea-roach."

One night an excursion was made with some men, hired for the purpose, to a place several miles from the ship, where shrimp are caught

for the Kingston market. I had a good opportunity to see how this was done, as we saw several parties at work. The place was reached at dark and proved to be a sheltered sheet of water along a swamp grown up to large trees. The water was little more than waist deep. The net used was about 15 feet long, 8 feet wide, one-half inch mesh, and was made of small twine. Light poles were fastened across the ends. The men grasped the poles and walked along parallel to the shore, holding the net at an angle of 45 degress, the net just clearing the bottom. After walking along 25 or 30 feet, the net was suddenly elevated to a horizontal position and the shrimp, fish, and crabs shaken down to the center and then thrown into the boat, which one of the men had been dragging behind him by fastening the painter around his waist. This is carried on in perfect silence. Several parties passed us working in exactly the same way.

After shrimp enough had been obtained, with some small fish and crabs, we lighted torches and landed, going into the swamp in search of land crabs, which are said to come out of their holes at night. Several very large ones were captured, also a large frog, much to the surprise of the men, who could see no use in collecting anything beyond what could be eaten or sold, and this frog, they said, "was not good to eat." On another excursion, coral was detached from the bottom and brought up in a body by means of a hook fastened to the end of a long pole. From this coral we obtained a number of small animals, among them a beautiful crab, an addition to our list. Several land crabs were dug out of their burrows in a mangrove swamp. When the spade cut through the upper layer of leaves and roots a quantity of very obnoxious gas would sometimes issue and compel us to abandon the digging. Hermit crabs of the genius *Cenobita* were common on a sandy ridge running through the swamp.

Kingston harbor was the first place where starfish were taken in any numbers. Here a 16-gallon tank was filled with fine specimens of an *Oreaster*. An excursion was made upon the mountain to the place where water is turned into the aqueduct which supplies the city of Kingston. Here we collected two species of crawfish, two species of fish, and some shells.

The Albatross sailed from Kingston March 11th. But three hauls were made between that port and Savanilla, where we arrived on the 16th. Excursions were made every day along the shores while there. The boat-dredge was used several times with fair results. One day was spent in hunting birds. Mr. Ridgway identified the following:

Ceryle torquata (Linn.).
Chrysotis amazonica (Linn.).
Ochthodromus wilsonius rufinucus (Ridgw.).
Ægialites semipalmata (Bp.).
Ereunetes pusillus (Linn.).
Ereunetes occidentalis (Lawr.).
Totanus melanoleucus (Gmel.).
Phalacrocorax brasiliensis (Gmel.).

Sailing from Savanilla on March 22, we arrived at Aspinwall on the 25th. Three dredgings were made on the way. Station 2143, in 155 fathoms, on the 23d, and a new crustacean allied to our common lobster was obtained, since described by Prof. S. I. Smith as *Eunephrops Bairdii*. During our stay no one was allowed to go on shore, as the city was unhealthy. The only collections made were by Mr. Nye, who in one way and another caught twelve or fourteen species of fish and two species of crabs from over the side.

We sailed from Aspinwall April 2. When 5 or 6 miles from the city, at Station 2145, a haul was made with the dredge in 25 fathoms. The dredge came up partly filled with mud and sand. On being washed out the following things were found: Three specimens of a small crustacean related to Hippa, but smaller and much more flattened than the Hippas we have collected on this cruise. They burrow in the mud with some ease, but I think from their actions they live in holes; one sea-urchin, much like Schizaster in appearance, with many dead and broken tests of the same; two species of brittle stars; worms (Eunicidæ and Terebellidæ); mollusks, many dead and few living. One of the latter is a *Yoldia*, very slender and delicate. Also a gorgonian coral, which consists of a single white stem, and seems to grow in the mud much like Pennatula. Station 2146, in 34 fathoms, was made the same day with the small beam-trawl, which came up with the net nearly torn from the frame by its rough contact with the bottom. The weight remaining in the net was considerable. As soon as possible a rope was made fast just above the load, and it was hoisted safely on board. The bulk of the material consisted of sponges and dead fragments of coral, the latter overgrown with bryozoa, and with here and there a living coral. One of the sponges was as large as could be preserved in a 16-gallon tank. This sponge was somewhat cylindrical in shape, with a deeply-concaved top. The surface was hard and unyielding; below this crust it was quite soft. A very much larger specimen of this sponge was too much broken to save. However, many brittle stars and worms were found hiding in its canals. Good specimens of five or six other sponges were picked out and placed in alcohol. Several specimens of a small *Fissurella* were found living in a sponge. Prominent among the treasures of this haul were the free crinoids. Three specimens of a large species were in excellent condition. The five rays divide at the disk into two parts. Each part subdivides into three and often four rays, making about forty stout rays rising close to the disk, and 6 or 7 inches in length. The dorsal aspect of the disk, the inner third of the dorsal cirri, and the ends of the pinnæ are yellow; otherwise the animal is a very dark brown, almost black.

Besides the foregoing, there were two smaller species, one of which we had taken before. The third is highly colored, its rays being variegated with red and yellow. Unlike *Antedon dentatum* these specimens all remained entire after having been placed in alcohol. A little octo-

pod was taken from its retreat in a piece of coral. It was not over two inches long. Its body was thickly sprinkled with reddish-brown spots, interspersed with innumerable specks of the same color. The spots extend in a double row part way to the ends of the arms, and some specks the entire length. Among the crustaceans was one related to *Callianassa*, also a spider-crab with a long, slender sponge growing to its carapace. Station 2147, in 34 fathoms, the same day was made with the tangle-bar, taking several species of slender gorgonian corals, bryozoa, compound ascidians, small crabs, brittle stars, &c. Station 2148 was also made the same day, in 130 fathoms, with the tangle-bar and dredge. Some soft mud adhered to the tangle and dredge, but no animals came to the surface.

During the afternoon of April 3, a school of fish was seen with a large flock of birds hovering over them. Occasionally the fish made the water white with foam. Mr. Nye observed them through a glass and had a fair view of their forms, as now and then one jumped from the water. In his opinion they closely resembled the common bluefish of our coast. In the evening of the same day, when the ship stopped to sound, several flying-fish were caught with the aid of the electric light. These fish were uninjured when taken and moved their fins with great rapidity through a small arc, while in my hands. Station 2149, in 992 fathoms, April 4, with the beam-trawl, taking in the net two shrimp, but no specimens from the bottom.

The Albatross dropped anchor in the harbor of Old Providence Island late in the afternoon of April 4. Like most of the islands we have visited on this cruise, it is hilly and rough. Cocoanut groves occupy the occasional strips of low land near the water. Grass is abundant and the cattle are the best we have seen. In one place the hillside is covered with a cotton-bearing shrub 6 to 8 feet in height. The cotton is said to bring 8 cents a pound.

The shores are in some places low; in others great rocks and ledges extend out into deep water. The rocks are for the most part a conglomerate from the surface of which the softer substances have been eroded by the action of the waves, leaving holes and recesses into which chitons, neritas, and turbas hide in large numbers. Far-outlying reefs protect the shores and surrounding waters from the severity of storms, making a large area of good feeding-ground for fish, upon which the inhabitants depend for a large proportion of their food.

A volunteer crew composed of officers and men made several hauls with the caplin seine, taking fish enough to supply the whole ship's company for some time. In one haul taken near the landing there were four or five bushels of a small fish called "sprat." After we had picked out all we wanted for food and bait, the people living near by carried away all that they could use. From the different hauls Mr. Miner picked out many specimens for preservation. The small mosquito net was used whenever practicable. Some species of small fish living about

corals and rocks we could not get by any means at our command. A large species of land crab (*Gecarcinus ruricola*), used as an article of food by the inhabitants, lives high up on the hills, far away from any water during the greater part of the year, and makes short burrows under stones and roots, from which it is easily taken. It is called by the people here the "black crab," though in reality it is purple. A stranger thing to me was finding hermit-crabs (*Cenobita*) living on the very tops of the hills, whither they climb carrying the heavy turba shells in which they almost invariably live. The first one of these crabs I saw was in a place to which I could climb only by taking hold of the shrubbery and pulling myself up by degrees. These hermit-crabs are used in large numbers for bait, for which purpose they are kept in confinement and fed on anything at hand, animal or vegetable. A number were kept on the ship many months, being fed principally on bread and fruit. We found large crawfish (*Palæmon Jamaicensis*) in the bed of what is a good-sized stream in the rainy season. Freshwater mullets and some other fish were seined. Snakes grow to a large size on the island, and are sometimes eaten. We collected three small specimens of as many species.

Bats live in a cave on the western side of Santa Catalina, an island separated from Old Providence by a narrow channel. A stop was made there on one of our excursions, and as many specimens procured as could be safely kept in a gallon of alcohol. Upon throwing gravel into their hidingplaces in the roof of the cave numbers flew about, carrying their young with their hind limbs. These bats are insectivorous, and belong to the group having leaf like appendages on the nose. The tide flows into the cave for a distance of 44 feet, beyond which there is a small sandy beach. The entrance at the base is about 25 feet, and 16 feet in height. In the sand at the farther end we found a few specimens of Hippa, much lighter in color than those common on the beaches outside. Under the loose stones, a little way in from the mouth, a number of starfish were taken, ranging in color from orange to reddish and purple. This cave is situated not far from what had once been a strongly fortified position of buccaneers, as the number of cannon strewn about would indicate, and it is not at all improbable that it was made use of by these outlaws.

One day was spent in hunting birds. But four species were killed, all of which have since been described as new by Mr. Ridgway in the Proceedings of the National Museum, viz: *Certhiola tricolor*, Ridgw., *Vireosylvia grandior*, Ridgw., *Vireo approximans*, Ridgw., and *Elainea cinerescens*, Ridgw.

We sailed for Key West on the morning of April 9. Station 2150, in 382 fathoms, was made the same day with the tangle and dredge, taking few foraminifera and shells. Station 2151, in 653 fathoms, on the 10th was made with the small beam-trawl, taking small crustaceans and some small fish, but no bottom specimens.

The Albatross arrived at Key West, Fla., April 15, and remained until the 27th. The time was used by collectors, as in more distant parts, in making a collection of fishes and marine invertebrates. However, more laboratory work was done here than anywhere else on the cruise. Scrapings from the wharfs—sponges, dead corals, and rotten wood—were placed in dishes day after day, and very many worms, crustaceans, and echinoderms, with some shells, sea-anemones, and other things, were taken as they came from their hidingplaces, and were killed in various fluids. Three large Oreasters were brought to the ship, which would not go into our largest tanks. The starfish were wrapped in cheese-cloth and put into a large dish-pan; a second pan of the same size was then inverted over the first, and they were soldered together. This improvised tank was then filled with alcohol through a small hole. Sponges, as is well known, are very abundant in the waters about Key West. Many small vessels are engaged in taking the species used in commerce. This work is much more laborious than formerly, as the supply has been, in a great measure, exhausted from the more shallow water. Now they are commonly taken from a depth of forty feet. I went about among the men at work in the sponge sheds and on the wharves, and made inquiry as to the cultivation of sponges. Men claiming to know all about the sponge fisheries of the whole Florida coast and the Bahama Islands declared that they had never known a sponge to be raised for the market. However, they seemed to have no doubt of the possibility of it, if it was desirable. All seemed to think that if sponge beds were laid out by the State, no matter how fairly they might be distributed at first, they would all eventually fall into the hands of a few, and the condition of the men employed in the fisheries be much worse than at present. Consequently, all were opposed to this experiment in any form.

Sailing from Key West on the 27th, we arrived in Havana early on the 28th. On the 30th we steamed out of the harbor and made twelve hauls with the tangle-bar, Stations 2152–2163, inclusive. Going into the harbor at night we continued the work outside on the following day, making six hauls, Stations 2164–2169, inclusive. These stations are all to the eastward and in sight of Morro Castle, in water from 29 to 387 fathoms in depth, where the bottom is very rough, often catching and holding the tangle-bar, making it necessary to maneuver the ship a good deal to free it. The object of search was the stalked crinoid (*Pentacrinus*). Upwards of one hundred specimens were brought up in the tangles. We found it necessary to put them in strong alcohol as soon as possible after they were taken from the water to prevent their going to pieces. Good specimens of free crinoids were also obtained at the same time, but none so striking as those dredged off Aspinwall. In addition to the crinoids there were hydroids, bryozoa, sponges, corals, brittle stars, and crustaceans of various groups. From off Havana the Albatross sailed for Cape San Antonio, the extreme western end of Cuba, where some

hydrographic work was done. In the evening of the 4th of May we came to anchor on a shoal near the cape. The electric light was put over the side, and myriads of small crustaceans taken by its help. While the ship remained at anchor the next day a tangle was used from the side, made by fastening short pieces of chain to an iron bar about two feet long. Short wires were twisted into the links of the chain to make it take hold of the bottom. This was thrown as far as possible away from the ship and then pulled in. This tangle worked well, and several dishes were filled with sponges and dead shells, from which many small animals came out as the water became stale. Among the worms I recognized *Podarke obscura*, described by Professor Verrill in U. S. F. C. Report, 1871–'72. It is very common at Wood's Holl, and appears to be quite as common off this cape. This was the last collecting done on the cruise. From Cape San Antonio we sailed for Key West, Fla., arriving on the 7th instant. Leaving the latter place on the 10th, we sailed for Washington, D. C., where we arrived on the 16th instant at 4.10 p. m.

The next cruise of the Albatross commenced on the 19th of July, at Norfolk, Va., and ended on the 26th of the same month, at Wood's Holl, Mass. During this cruise thirteen hauls were made, all of which were successful in taking specimens from the bottom. Shortly after leaving our first station, 2170, I was informed that we had passed several cuttle-fish which were floating dead on the surface. I reported this to Captain Tanner, and when another was seen he stopped the ship and ordered a boat to be lowered to pick it up. I went in the boat, and with a scoop-net procured four specimens. They proved to be octopods (*Alloposus mollis*). One was in sufficiently good condition to bear handling, and seems to be yet in a fair state of preservation. The others were too much decomposed to amount to anything, though we saved them in fragments as best we could. A little later in the day a good specimen was procured which was not removed from the scoop-net until it could be turned into a large tank of alcohol. When out in the boat several fragments of the octopus were seen, but our specimens when taken were to all appearances entire. It was impossible to make any measurements; however, some idea of their size can be given, as one just about filled a common water pail. These large cephalopods were sighted in varying numbers for a distance of 75 miles. The ship was sounding and dredging in the mean time, occupying portions of two days in making that distance. It is not unreasonable to suppose that the area covered by these animals extended over the square of this distance, and allowing ten animals to the square mile, which is not a large estimate, as seven or eight were frequently seen at one time, would give a total number of 56,250 animals.

On the morning of the 21st, several squid were picked up with a scoop-net from the ship's side, all more or less mutilated. I made them out to belong to the genus *Calliteuthis*. Two squid (*Ommastrephes*)

were taken alive with a scoop-net in the evening of the same day as they came up to the ship, attracted by the arc light. On the morning of the 23d, a large octopod was taken in the trawl-net. It is no doubt the *Eledone verrugosa* of Verrill, but it is much larger than the type specimens of that species. Besides the foregoing, several other interesting cephalopods were taken during the cruise. On the 23d we filled a large tank (16 gallons) with crabs, *Geryon quinquedens*. At Station 2176 we filled a 4-gallon tank with ophiurans, and nearly filled another of the same size with fine sea-urchins (*Schizaster*). Among the other invertebrates were a number of cup corals, genus *Flabellum*, one of unusual size and shape; pennatulæ; starfish (*Zoroaster* and *Archaster*); many shrimp; a few shells; several species of holothurians; and many surface animals. During the cruise quite a number of fish were preserved, some of them being rare.

On the 24th the ship put into Newport, R. I., and having procured bait, sailed on the following day for Cox's Ledge, where all of the lines in the ship were put to use and a large number of cod and other fish were taken during the short time we remained there. On the morning of the 26th we arrived in Wood's Holl, Mass.

We left again on the 31st for Newport, R. I., to procure bait, and on the following day started for Cox's Ledge, where several hours were spent fishing with hand-lines. Many dogfish were caught, with now and then a cod or a hake. The naturalists were busy during the fishing in collecting parasites and examining the stomachs of fish. According to instructions the different glands of the dogfish desired by Mr. Peters were preserved in Müller's fluid. The morning of August 2d found us on the tilefish ground. Two long trawl-lines were baited in readiness, one of which was set in the morning and one in the afternoon. The fish taken in the morning were identified by Mr. Parker as follows: *Phycis tenuis*, 97 specimens; *Phycis chuss*, 6; *Merlucius bilinearis*, 2; *Raia lævis* ♂, 1; *Squalus acanthias*, 49. Those in the afternoon were: *Phycis tenuis*, 65 specimens; *Phycis chuss*, 3; *Raia lævis*, 3; *Raia ocellata*, 2; *Merlucius bilinearis*, 4. Four hauls of the beam-trawl were made during the day with the following results: Station 2183, in 195 fathoms, worms and worm-tubes, brittle stars, starfish, and fish as follows: *Macrurus carminatus*, 4 specimens; *Glyptocephalus cynoglossus*, 2; *Halieutæa senticosa*, 2. Station 2184, in 136 fathoms, resulted in our getting a few invertebrates; *Phycis tenuis*, 2 specimens; *Glyptocephalus cynoglossus*, 1; *Scorpæna dactyloptera*, 3. Station 2185, in 129 fathoms: *Ophiomusium Lymani*, a number; *Lætmatonice armata*; *Phycis tenuis*, 2; *Phycis chuss*, 5; *Paralichthys oblongus*, 1; *Raia radiata*, 1. Station 2186, in 353 fathoms: *Acanella Normani*; *Polynoe acanella*; Actinias. Fish—*Macrurus Bairdii*, 25; *Phycis Chesteri*, 4; *Merlucius bilinearis*, 1; *Cottunculus torvus*, 3; *Halieutæa senticosa*, 1; *Centroscyllium Fabricii*, 1; *Glyptocephalus cynoglossus*, 4; *Synaphobranchus pinnatus*, 2; *Amitra liparina*, 2. The trawl-line was again set on the following day,

and fish taken as follows: *Phycis tenuis*, 96; *Phycis chuss*, 2; *Merlucius bilinearis*, 15; *Raia lævis*, 1 ♂ and 2 ♀; *Squalus acanthias*, 1. Station 2187, in 420 fathoms: *Acanella Normani*, worm-tubes, Archasters in large numbers, 8 *Octopus Bairdii.* Fish—*Phycis Chesteri*, 3; *Merlucius bilinearis*, 6; *Glyptocephalus cynoglossus*, few; *Macrurus Bairdii*, few; *Raia radiata*, 2; *Lycodes Verrillii*, 1; *Nemichthys scolopaceus*, 1; *Amitra liparina*, 2; *Scopelus*, sp. 4; *Synaphobranchus pinnatus*, 4; *Cottunculus microps*, 1; *Sebastes marinus*, 1. Station 2188, in 235 fathoms: few invertebrates. Fish—*Scopelus*, 4. Station 2189, in 600 fathoms, used beam-trawl: few invertebrates; *Macrurus Bairdii*, 8; *Haloporphyrus viola*, few; *Cottunculus torvus*, 1; *Synaphobranchus pinnatus*, 1; *Glyptocephalus cynoglossus*, 1. Station 2190, in 480 fathoms, on August 4: no invertebrates. Fish—*Berycidæ*, 1; *Cyclothone lusca*, 4. Station 2191, the trawl was lost. Station 2192, in 1,060 fathoms, August 5; the trawl came up with large lumps of mud filled with the burrows of some unknown animal. When broken up, some small corals and a number of worms were found in the burrows. The mud was hard and contained a small amount of sand. The only invertebrates not saved were the large holothurians, *Benthodytes.* Fish—*Alepocephalus*, sp. 1; *Coryphænoides carapinus*, 2; *Stomias*, 1. Station 2193, in 1,122 fathoms: *Ophiomusium Lymani;* Pycnogonids; *Lithodes; Benthodytes.* Fish—*Macrurus asper*, few; *Haloporphyrus viola*, many. Station 2194, in 1,140 fathoms. Fish—*Synaphobranchus pinnatus*, 1; *Cottunculus microps.* Station 2195, in 1,058 fathoms: cup corals, starfish, Pycnogonids. Fish—*Haloporphyrus viola*, 20; *Macrurus asper*, 6. Station 2196, in 1,230 fathoms, on August 6: large crabs (*Lithodes*); corals (*Flabelium*); *Ophiomusium Lymani: Benthodytes;* a large number of Pycnogonids. Fish—*Macrurus asper*, 1; *Haloporphyrus viola*, 16; *Coryphænoides rupestris*, 5. Station 2197, in 84 fathoms: sponges, worms, crabs, shells. Fish—*Phycis chuss; Sebastes marinus; Paralichthys oblongus; Raia eleganteria.* Station 2198, in 84 fathoms; few sponges only. Station 2199, in 78 fathoms; sponges and worms. Fish—*Phycis chuss*, 6; *Citharichthys arctifrons*, 3; *Lophius piscatorius*, juv. 1; *Paralichthys oblongus.* Station 2200, in 148 fathoms: sponges, worms, crabs, and shells. Fish—*Macrurus carminatus*, 3; *Merlucius bilinearis*, 1; *Raia radiata*, 1; *Scorpæna dactyloptera*, 1. Trawl-line, August 6: *Squalus acanthias*, 7; *Scyllium retiferum*, 1; *Phycis chuss*, 15.

We arrived in Wood's Holl on the 7th.

On August 18 the Albatross again put to sea for a short dredging cruise, returning on the 24th, having made 19 hauls with the beam-trawl and one with the Blake dredge. The average depth of the hauls were 833 fathoms. Surface work was carried on every day with some very interesting results. The flying squid, *Sthenoteuthis Bartramii* (Verrill), uncommon in collections and supposed to be much more southern in its range, was taken at night with the squid jig, the Edison light being lowered two feet below the surface of the water to attract

them and their food to the ship. These squid appear to go in schools, as they appeared and disappeared together in numbers varying from ten to fifty. One hundred and twenty-five of various sizes were preserved in alcohol. Twenty-five taken on the night of the 23d were placed alive in a large tub, and the water was kept fresh during the night by a continuous flow from the deck pump. In the morning nearly all were found to be dead, and all were badly mutilated by the beaks of their fellows. One evening a flying-fish was captured with a scoop-net and was killed in alcohol with its fins extended.

At about 10.45 one night Mr. Nye saw a phosphorescent mass near the ship and tried to bring it on board with a scoop-net. In this he did not succeed, but in his effort captured a shrimp of the deep red color so characteristic of many of the deep sea crustaceans. This is the only specimen of this color we have ever taken from the surface. The question naturally comes up, Could not this one have been dredged and been in the scoop-net or on the deck where the net was emptied? I am sure that it could not; for although shrimp of this color have been taken from every haul made in deep water, I have never seen one alive, while the one taken from the surface lived half an hour in a dish. This shrimp was not in the least phosphorescent. *Acanella Normani* came up plentifully in some hauls. It has been a common thing to find single egg-cases about the size of a nutmeg attached to this coral. Until this cruise no embryos have been found far enough advanced to determine to what they belonged. We found one, however, with a well-advanced embryo of an octopod. This, with the egg-shell and case still attached to the coral, is preserved, and it may be possible to determine the genus and perhaps the species. The Anthozoa from the various hauls were valuable. One Pennatula is at least new to our coast and perhaps to science. Echinoderms were numerous, and I believe several new forms will be found among them. The list of mollusks will be large. The principal things in the various hauls were as follows: Station 2201, in 538 fathoms, August 19: Archasters; crabs (*Geryon quinquedens*); shrimp, several species. Just after this haul several large dead octopods were seen on the surface as on a previous occasion. A boat was lowered and a portion of one picked up. It proved to be *Alloposus mollis* (Verrill). Station 2202, in 515 fathoms: *Geryon quinquedens*, numerous; *Eledone verrugosa;* shrimp, worms, and worm-tubes; foraminifera; 12 species of fish. Station 2203, in 515 fathoms: trawl came up with a heavy load of mud; one large *Lithodes Agassizii* ♀; *Geryon quinquedens;* large soft sea-urchins (*Phormosoma*); starfish; cup corals; *Macrurus Bairdii;* and 8 other species of fish. Station 2204, in 728 fathoms: *Geryon quinquedens; Flabellum;* starfish; sea-urchins; 9 species of fish. Station 2205, in 1,073 fathoms, August 20: *Benthodytes gigantea*, 60 large specimens; *Acanella Normani; Anthoptillum;* 3 species of Cephalopods; and 8 species of fish. Station 2206, in 1,043 fathoms: *Geryon quinquedens; Echinus norvegicus;* soft sea-urchins (*Phormosoma*); and 8 species of

fish. Station 2207, in 1,051 fathoms; large load of mud, with worms and brittle stars. After this haul 48 flying squid were taken around the electric light, with a squid-jig. Station 2208, in 1,178 fathoms, August 21: *Acanella Normani* and *Echinus norvegicus*, with a few worms, shells, and fish. Station 2209, in 1,080 fathoms: *Echinus norvegicus*, *Phormosoma*, shrimp, shells, and eight species of fish. Station 2210, in 991 fathoms: a good haul of Anthozoa, among them one form new to the Albatross collections; sea-urchins, starfish, shells, worms, and ten species of fish. Station 2211, in 1,064 fathoms: much material, small shrimp, starfish, and four species of fish. Station 2212, in 428 fathoms, August 22: a heavy load of mud, with worms, shells, and some starfish; also, five species of fish. Station 2213, in 384 fathoms: contents of net, same as previous haul. Station 2214, in 475 fathoms: one sea-urchin, worms, shells, and four species of fish. Station 2215, in 578 fathoms: worms, brittle stars, and four species of fish. Station 2216, in 956 fathoms: large flat sea-urchins, cup coral, and eight species of fish. Station 2217, in 924 fathoms, August 23: *Ophiomusium Lymani*, starfish, worms, shells, soft sea-urchins, and one fish. Station 2218, in 948 fathoms, with Blake dredge: mud, worms, and shells. Station 2219, in 948 fathoms: very few invertebrates, and two species of fish. Station 2220, in 1,054 fathoms: sea-urchins, shells, and two species of fish.

We arrived in Wood's Holl on August 24.

On the 5th of September the Albatross again put to sea for a cruise in the deep waters between Wood's Holl and the Bermuda Islands and in the region of the Gulf Stream, returning on the 14th of the month. Eighteen hauls were made with the beam-trawl in an average depth of 1,360 fathoms; the maximum depth being 2,574 and the minimum 243 fathoms. Surface collecting was carried on in the usual manner with nets, and at night with the aid of the electric light. The flying squid (*Sthenoteuthis Bartramii*) was not abundant, only two specimens being taken on the cruise

On the 6th two hauls were made, Stations 2221 and 2222 in 1,525 and 1,537 fathoms, respectively. The former brought up a heavy load of mud and ooze. From this we washed out a large amount of foraminifera. An ophiuran of small size was very abundant, as were shells of several species. For the first time we found a species of brachiopod numerous. *Gersemia longiflora*, Verrill, was abundant. Several very large specimens of *Benthodytes gigantea*, Verrill, were preserved. In lesser numbers were shrimp, ascidians, and starfish. At the second haul we did not obtain so much ooze and mud, but the same species of ophiurans, so abundant in the first haul, were more abundant in this. Shells were not numerous. *Gersemia longiflora* and *Benthodytes* were again preserved. Several bricks, with mortar attached, were dredged at this station, also a very large number of small fragments of the same material. The mortar appears to have been exposed to fire. Four species of fish were taken also at this station. At Station 2223, on the

7th instant, the trawl was put over in the Gulf Stream. The current was very strong, and we were unsuccessful in obtaining bottom specimens, although the shrimp and cephalopods show that the trawl was near the bottom. The wing-nets, however, contained a good number of small things. The depth of water at this station was 2,516 fathoms. While the rope was out Captain Tanner saw a large octopod floating on the surface, and ordered the dinghy to be lowered to pick it up. This was successfully done. Owing to the strength of the current the dinghy was unable to regain the ship until the trawl was in, some two or three hours afterwards, and the vessel ran down and picked us up. The octopod proved to be a badly mutilated specimen of *Alloposus mollis*. Last season no large octopods were found on the surface, while this season we have found *Alloposus mollis* on every cruise floating dead—sometimes badly mutilated and sometimes nearly whole. During the evening of the same day, while some of the men were jigging for squid, a shark was seen swimming about near the light. A large hook was at hand and the shark was soon caught. It measured seven feet three inches in length, and was identified as *Aprionodon punctatus* ♀. Five young were taken out and preserved. Another shark of this species was caught on the 13th, which measured seven feet seven inches in length. From this specimen parasites both external and internal were taken. At another time a small shark thirty inches in length was taken under the light.

The following is a partial list of the invertebrates taken during the cruise: Station 2224, in 2,574 fathoms, September 8, taking mud-bag half filled with ooze; trawl contained *Ophioglypha convexa;* shrimp; one large *Galicantha;* a few species of mollusks; one whole and several fragments of cephalopods. Station 2225, in 2,512 fathoms, September 9: *Ophioglypha convexa;* shells; 1 cephalopod; clay and ooze. Station 2226, in 2,021 fathoms, September 10: three large specimens of *Aristeus tridens*, and also several small shrimp; Archasters and other starfish; *Ophiomusium armigerum; Ophioglypha convexa.* Station 2227, in 2,109 fathoms, September 10; trawl lost. Station 2228, in 1,582 fathoms, September 11: a heavy load of clay, with bryozoa, hydroids, and sponges. Station 2229, in 1,423 fathoms: *Benthodytes gigantea; Archaster grandis;* brittle stars; sponges; shells; foraminifera. Station 2230, in 1,168 fathoms, September 12: *Anthomastus grandiflorus* attached to stones; *Benthodytes gigantea*, 15 specimens. Station 2231, in 965 fathoms: a load of mud and ooze, with some small worms and shells. Station 2232, in 243 fathoms: *Octopus Bairdii*, two specimens; brittle stars; starfish; shrimp; and shells. Station 2233, in 630 fathoms: load of mud, with two specimens of *Archaster Agassizii;* one specimen of *Geryon quinquedens;* few shells. Station 2234, in 816 fathoms, September 13: *Geryon quinquedens; Phormosoma uranus; Flabellum;* shells; shrimp. Station 2235, in 707 fathoms: *Geryon quinquedens*, numerous; *Phormosoma uranus;* shells. Station 2236, in 636 fathoms: *Geryon quinquedens*, one specimen;

worms; and few shells. Station 2237, in 520 fathoms; same as previous haul. Station 2238, in 904 fathoms; trawl empty.

We arrived in Wood's Holl on the 14th. On the 25th we sailed for a short cruise in the shallow waters south of Martha's Vineyard. On the 26th, eight hauls were made in water from 32 to 122 fathoms in depth. The general character of the bottom was green mud and sand. As was to be expected, the fishes and invertebrates were well known. Large numbers of *Pecten tenuicostatus; Archaster americanus; Ophioglypha Sarsii*, *Asterias vulgaris*, and *Lætmatonice armata* were saved for distribution. The electric light was used at night, and 177 specimens of the flying-squid, *Sthenoteuthis Bartramii* were caught with the jig. On the 27th nine hauls were made in water from 18 to 78 fathoms in depth. The first five or six hauls were much similar to those of the day before, but gradually the bottom became more sandy, and we began to take the sand-dollars, *Echinarachnius parma*, a few at first, and more and more until the last haul, when the table sieve was heaped up with them. On the 28th, 7 hauls were made in water from 30 to 250 fathoms in depth. The first haul brought us a large number of sand-dollars and a few shells. Later we obtained many beautiful specimens of *Asterias vulgaris*. The last haul was in 250 fathoms, and was the largest haul of worm-tubes we have ever taken. We returned to Wood's Holl on the 29th, and on October 8th we left for New York, where we arrived the following day. We remained at the latter place until the 17th, when we sailed on our final cruise off Cape Hatteras. On the 18th three hauls were made; the second and third remarkable for the large numbers of Munidas and other forms which had been common on the tilefish ground before that fish disappeared. On the following day twenty-one hauls were made, mostly in shallow water. At Station 2267, in 68 fathoms, the trawl- net was torn. The few specimens taken were highly colored echinoderms and corals, showing that the trawl had caught on a reef. The tangles were put over in the same place and additional specimens of the same kind taken. After this haul the water became shallower and the trawl-net brought up only a few specimens of crabs and starfish and broken shells. The mud-bag came up well filled with mud, from which we sifted large numbers of dead shells. This continued all day, interrupted only by haul 2,280, which brought up a large quantity of corals, shells, crabs, &c. On the 20th fourteen hauls were made, the first part of the day, with about the same results as on the previous day. Station 2297, in 49 fathoms, was a surprise to us. A large lobster (*Homarus americanus*) made its appearance and a very large number of crabs (*Cancer borealis* and *C. littoralis*). On the 21st the tangles were used on the reef that we had found two days before, with good results.

We then started for Washington, where we arrived October 23d.

Dredging and Trawling Record of the United States Fish Commission steamer Albatross, Season of 1884.

ABBREVIATIONS USED IN THIS TABLE: m., mud; s., sand; g., gravel; co., coral; sh., shells; p., pebbles; sp., specks; c., clay; st., stones; r., rock; bk., black; wh., white; yl., yellow; gy., gray; bu., blue; dk., dark; lt., light; gn., green; br., brown; hrd., hard; sft., soft; fne., fine; crs., coarse; brk., broken; lrg., large; sml., small; rky., rocky; stk., sticky; oz., ooze; for., foraminifera; glob., globigerina; L. B. T., large beam-trawl; S. B. T., small beam-trawl; Tgl. bar, tangle-bar; Bl. Dr., Blake dredge; Sh. Dr., Ship's dredge. Bl. Dr. = D. S. (deep-sea dredge), and Sh. Dr. = M. B. (mud-bag).

Serial No.	Date.	Time.	Positions.		Temperatures.			Depth in fathoms.	Character of bottom.	Wind.		Drift.		Instrument used.
			Latitude N.	Longitude W.	Air.	Surface.	Bottom.			Direction.	Force.	Direction.	Distance.	
	1884.		° ′ ″	° ′ ″									Miles.	
2117	Jan. 27	1.58 p. m.	15 24 40	63 31 30	84	78	39.75	683	yl. m. fne. s	ENE.	2	NW. by W.	2.5	L. B. T.
2118	Jan. 28	8.15 a. m.	13 32 40	62 54 00	76	77	....	690	gy. m. bk. s	SE.	2	ENE.	1.7	Do.
2119	Jan. 29	1.07 p. m.	11 48 30	62 17 30	75	77	39.25	1,140	gy. m	NE.	3	SW.	2.5	Do.
2120	Jan. 30	6.30 a. m.	11 07 00	62 14 30	76	76	....	73	bu. m	E.	2	N.	0.2	Dr. Tgl.
2121	Feb. 3	6.37 a. m.	10 37 40	61 42 40	76	77	67	31	dk. slate-col. m	NW. by W.	2	....	....	L. B. T.
2122	Feb. 3	7.18 a. m.	10 37 00	61 44 22	77	77	73	34	dk. slate-col. m	NW. by W.	2	....	....	Do.
2123	Feb. 3	8.45 a. m.	10 42 02	61 48 48	78	78	64.5	117	bu. m	NE. by N.	2	....	....	Do.
2124	Feb. 18	2.03 p. m.	11 31 30	69 02 10	77	74	59.5	122	fne. sh. gn. m	E. by S.	2	NW. by N.	....	Sh. Dr.
2125	Feb. 18	4.31 p. m.	11 43 00	69 09 30	75	74	50.7	208	yl. m. s. bk. sp	E. by N.	2	W. by S.	....	S. B. T.
2126	Feb. 19	10.11 a. m.	13 17 45	70 01 00	78	77	39.3	1,701	yl. m. crs. s. for	ENE.	3–4	NNE.	....	Do
2127	Feb. 25	3.14 p. m.	19 45 00	75 04 00	78	77	....	1,639	gn. m	WSW.	3	W. ½ S.	....	L. B. T.
2128	Feb. 27	10.58 a. m.	19 55 46	75 49 23	78	78	49.5	400	bu. m. fne. s	SE.	1	E. to ENE.	....	Tgl. bar.
2129	Feb. 27	12.25 p. m.	19 56 04	75 48 55	77	78	....	274	bu. m. fne. s	SE.	2	E. to ENE.	....	Do.
2130	Feb. 27	1.04 p. m.	19 56 25	75 49 49	77	79	....	175	gy. m. s. brk. sh	SE.	2	E. to ENE.	....	Do.
2131	Feb. 27	2.00 p. m.	19 56 44	75 50 49	78	79	....	202	hrd. crs. s	SE.	3	E. to ENE.	....	Do.
2132	Feb. 27	3.33 p. m.	19 55 38	75 49 16	78	79	....	478	yl. m. brk. sh	SE.	3	E. to ENE.	....	Do.
2133	Feb. 27	4.30 p. m.	19 55 55	75 48 03	79	79	....	290	wh. s. brk. sh	SE.	3	E. to ENE.	....	Do.
2134	Feb. 27	5.37 p. m.	19 56 06	75 47 32	77	78	....	254	....	SE.	3	ESE.	....	Do.
2135	Feb. 27	6.31 p. m.	19 55 58	75 47 07	77	77	....	250	hrd. co	SE.	3	ESE. to SSE.	....	Do.
2136	Feb. 29	2.04 p. m.	17 43 40	75 38 25	81	78	....	52	co. brk. sh	SE.	3	NW. by W. ⅜ W.	....	Do.
2137	Feb. 29	2.29 p. m.	17 44 50	75 39 20	81	78	....	47	co. brk. sh	SE.	3	NW. by W. ⅜ W.	....	Do.
2138	Feb. 29	5.36 p. m.	17 44 05	75 39 00	78	78	....	23	co. brk. sh	SE.	3	S. ½ E.	....	Do.
2139	Mar. 11	2.56 p. m.	17 52 00	76 45 30	80	79	62.3	215	bk. m	ESE.	4	....	....	Do.
2140	Mar. 11	7.18 p. m.	17 36 10	76 46 05	80	78	39.7	966	s	E.	3	NNE. ½ E.	....	S. B. T.
2141	Mar. 12	11.29 a. m.	17 25 00	75 59 55	78	77	....	5	co. s	E	5	S. by E. ¾ E.	....	Tgl. bar.
2142	Mar. 23	4.05 p. m.	9 30 15	76 20 30	81	81	....	42	gn. m. s	WNW.	2	W. ½ S.	....	S. B. T.
2143	Mar. 23	5.01 p. m.	9 30 45	76 25 30	80	80	....	155	gn. m	NNW.	2	W. ½ S.	....	Do.
2144	Mar. 25	6.46 a. m.	9 49 00	79 31 30	78	79	....	896	gn. m	N.	1	SSW.	....	L. B. T.
2145	Apr. 2	10.41 a. m.	9 27 00	79 54 00	80	79	....	25	gn. m. brk. sh	NNE.	4	....	....	Sh. Dr.
2146	Apr. 2	12.03 p. m.	9 32 00	79 54 30	80	79	....	34	brk. sh	NNE.	4	....	....	L. B. T.
2147	Apr. 2	12.46 p. m.	9 32 20	79 54 45	80	79	78.5	34	co	NNE.	4	....	....	Tgl. bar.

2148	Apr.	2	1.39 p. m.	9 35 00	79 55 30	81	79	78.25	130	hrd	NNE.	4			
2149	Apr.	4	9.31 a. m.	13 01 30	81 25 00	80	78	39.7	992	yl. m	NE. by N.	3			Do.
2150	Apr.	9	9.15 a. m.	13 34 45	81 21 10	82	78	45.75	382	wh. crs. s	NNE.	3			Do.
2151	Apr.	10	11.03 a. m.	15 28 39	80 36 00	79	78	40.2	653	yl. for. oz	NE. to ENE.	3			Dr. & Tgl. bar.
2152	Apr.	30	6.05 a. m.	2½ m. NW. of Havana Light.		71	77	49	387	co	ESE.	1			L. B. T.
2153	Apr.	30	7.11 a. m.	23 10 19	82 23 10	74	77	55.8	283	co	ESE.	2			Tgl. bar.
2154	Apr.	30	8.08 a. m.	23 10 16	82 22 54	76	77	59.6	310	co	ESE.	2			Do.
2155	Apr.	30	9.09 a. m.	23 10 21	82 22 41	76	77		300	co	ESE.	3			Do.
2156	Apr.	30	10.42 a. m.	23 10 35	82 21 55	78	77	59.8	278	co	E. by N.	4			Do.
2157	Apr.	30	11.40 a. m.	23 10 04	82 21 07	78	77		29		ENE.	3			Do.
2158	Apr.	30	12.07 p. m.	23 10 25	82 20 36	78	77		86		ENE.	3			Do.
2159	Apr.	30	1.05 p. m.	23 10 39	82 20 08	80	77		98	co	ENE.	3			Do.
2160	Apr.	30	2.04 p. m.	23 10 31	82 20 37	79	77		167	co	ENE.	4			Do.
2161	Apr.	30	2.48 p. m.	23 10 36	82 20 28	78	78		146	co	ENE.	4			Do.
2162	Apr.	30	3.36 p. m.	23 10 30	82 20 25	79	78		122	co	ENE.	4			Do.
2163	Apr.	30	4.24 p. m.	23 10 31	82 20 29	79	78		133	co	ENE.	4			Do.
2164	May	1	6.21 a. m.	23 10 39	82 20 29	71	77		192	co	ESE.	2			Do.
2165	May	1	7.19 a. m.	23 10 39	82 20 28	71	77		200	co	ESE.	2			Do.
2166	May	1	8.27 a. m.	23 10 36	82 20 30	74	77	71.9	196	co	ESE.	3			Do.
2167	May	1	9.33 a. m.	23 10 40	82 20 30	80	78		201	co	ESE.	3			Do.
2168	May	1	10.24 a. m.	23 10 36	82 20 20	80	78		122	co	ESE.	3			Do.
2169	May	1	10.46 a. m.	23 10 28	82 20 27	79	78		78	co	ESE.	3			Do.
2170	July	20	11.40 a. m.	37 57 00	73 53 30	72	71		155	gy. s	NE.	2			Do.
2171	July	20	1.25 p. m.	37 59 30	73 48 40	75	75	39.5	444	gn. m	NNW.	2			Do.
2172	July	20	3.45 p. m.	38 01 15	73 44 00	76	76	39	568	gn. m	NW.	1			Do.
2173	July	21	6.26 a. m.	37 57 00	72 34 00	70	70	37	1,600	glob. oz	NNW.	1			Do.
2174	July	21	2.59 p. m.	38 15 00	72 03 00	73	76		1,594	gy. m	W.	4			Do.
2175	July	22	9.03 a. m.	39 33 00	72 18 30	69	68	40.5	452	gn. m	WSW.	4			Do.
2176	July	22	12.34 p. m.	39 32 30	72 21 30	71	68	41	302	bk. m	WSW.	3			Do.
2177	July	22	3.40 p. m.	39 33 40	72 08 45	71	68	52	87	gn. m. s	W. by N.	3			S. B. T.
2178	July	22	5.16 p. m.	39 29 00	72 05 15	70	68	42.3	229	gn. m. s	WSW.	4			L. B. T.
2179	July	23	4.02 a. m.	39 30 10	71 50 00	68	67	39.5	510	bk. m	WSW.	4			Do.
2180	July	23	6.48 a. m.	39 29 50	71 49 30	72	68	39.5	523	bk. m	WSW.	3			Do.
2181	July	23	9.42 a. m.	39 29 00	71 46 00	75	68	39	693	gy. m. fne. s	WSW.	3			Do.
2182	July	23	12.58 p. m.	39 25 30	71 44 00	70	68	39	861	gn. m	SW.	5			Do.
2183	Aug.	2	11.52 a. m.	39 57 45	70 56 30	69	68	44.5	195	gn. m. s	SE.	1	NE.	.75	Do.
2184	Aug.	2	1.08 p. m.	40 00 15	70 55 30	71	70	48.9	136	gn. m. s	SE.	1	NE.	1	Do.
2185	Aug.	2	2.12 p. m.	40 00 45	70 54 15	74	69	51	129	gn. m. s	SE	1	N. by E.	1	Do.
2186	Aug.	2	6.12 p. m.	39 52 15	70 55 30	70	69	39.7	353	gn. m. s	SW.	1	WNW.	.50	Do.
2187	Aug.	3	10.44 a. m.	39 49 30	71 10 00	70	68	39.7	420	gn. m. s	ESE.	3	ENE.	.75	Do.
2188	Aug.	3	1.54 p. m.	39 54 30	71 08 00	73	70	42.7	235	gn. m. s	ESE.	2	E. by S.	.75	Do.
2189	Aug.	4	4.16 a. m.	39 49 30	70 26 00	71	71	39.7	600	gn. m. s	WSW.	3	ESE.	1	Do.
2190	Aug.	4	10.42 a. m.	39 40 00	70 20 15	74	73		1,180	glob. oz	SSW.	4	ENE.	1	Do.
2191	Aug.	4	2.46 p. m.	39 45 30	70 17 00	74	73		961	gn. m	SW.	5	NE.	1	Lost trawl.
2192	Aug.	5	5.45 a. m.	39 46 30	70 14 45	76	72	38.6	1,060	gy. oz	SSW.	4	NNE.	.75	L. B. T.
2193	Aug.	5	11.04 a. m.	39 44 30	70 10 30	79	73	38.4	1,122	gn. m	SSW.	5	S.	1.5	Do.
2194	Aug.	5	2.54 p. m.	39 43 45	70 07 00	77	74	38.4	1,140	oz	SSW.	4	S. by E.	1.25	Do.
2195	Aug.	5	6.42 p. m.	39 44 00	70 03 00	83	74	38.4	1,058	gn. m	SSW.	4	S.	1.5	Do.
2196	Aug.	6	4.45 a. m.	39 35 00	69 44 00	74	74	38	1,230	gn. m	SSW.	3	NNW.	1.5	Do.
2197	Aug.	6	11.24 a. m.	39 56 30	69 43 20	77	74	52.3	84	s. brk. sh	S.	2	NE.	1.5	Do.
2198	Aug.	6	1.17 p. m.	39 56 30	69 43 20	78	74	52.3	84	s. brk. sh	SSW.	2	NE.	2	Do.
2199	Aug.	6	2.03 p. m.	39 57 30	69 41 10	77	74		78	gy. s	SSW.	2	WSW.	1	Do.

Dredging and Trawling Record of the United States Fish Commission steamer Albatross, Season of 1884—Continued.

Serial No.	Date.	Time.	Positions.		Temperatures.			Depth in fathoms.	Character of bottom.	Wind.		Drift.		Instrument used.
			Latitude N.	Longitude W.	Air.	Surface.	Bottom.			Direction.	Force.	Direction.	Distance.	
	1884.		° ′ ″	° ′ ″									Miles.	
2200	Aug. 6	4.38 p. m.	39 53 30	69 43 20	77	74	45	148	crs. s. bk. sp	SSW.	2	SE. by E.	2	L. B. T.
2201	Aug. 19	6.10 a. m.	39 39 45	71 35 15	69	66	39.5	538	bu. m	NNE.	5	W.	2	Do.
2202	Aug. 19	9.23 a. m.	39 38 00	71 39 45	70	67	39.1	515	gn. m	N.	6	WSW.	1.75	Do.
2203	Aug. 19	12.29 p. m.	39 34 15	71 41 15	74	74	38.9	705	gn. m. s	NNW.	6	WSW.	2.5	Do.
2204	Aug. 19	4.32 p. m.	39 30 30	71 44 30	71	74	39.1	728	br. m	W.	4	WSW.	2.5	Do.
2205	Aug. 20	4.37 a. m.	39 35 00	71 18 45	68	73	38.1	1,073	gy. oz	NW.	4	W. by S.	1.25	Do.
2206	Aug. 20	9.16 a. m.	39 35 00	71 24 30	71	74	38.4	1,043	gn. m	NW.	2	NNE.	1.25	Do.
2207	Aug. 20	1.01 p. m.	39 35 33	71 31 45	77	74	38.6	1,061	gn. m	W.	1	NNE.	1.25	Do.
2208	Aug. 21	5.02 a. m.	39 33 00	71 16 15	75	74	38.4	1,178	gn. m	W by N.	3	WSW.	1	Do.
2209	Aug. 21	9.42 a. m.	39 34 45	71 31 30	76	74	39.5	1,080	gn. m. s	WNW.	2	E.	1.25	Do.
2210	Aug. 21	1.18 p. m.	39 37 45	71 18 45	75	74	38.1	991	glob. oz.	SW.	5	S. by W.	1.5	Do.
2211	Aug. 21	4.45 p. m.	39 35 00	71 18 00	74	74	38.3	1,064	gy. oz	SW by S.	3	S. by W.	2	Do.
2212	Aug. 22	4.48 a. m.	39 59 30	70 30 45	72	71	40	428	gn. m	SSW.	2	E.	.5	Do.
2213	Aug. 22	8.04 a. m.	39 58 30	70 30 00	73	71	39.5	384	gn. m	SSW.	2	S. by W.	1.5	Do.
2214	Aug. 22	11.30 a. m.	39 57 00	70 32 00	74	74	39.5	475	gn. m	SW.	3	SSW.	1.75	Do.
2215	Aug. 22	3.13 p. m.	39 49 15	70 31 45	77	74	....	578	lost ther	SSW.	4	SW.	1.5	Do.
2216	Aug. 22	5.38 p. m.	39 47 00	70 30 30	81	71	39.5	963	gn. m	SSW.	2	S.	1.75	Do.
2217	Aug. 23	4.49 a. m.	39 47 20	69 34 15	75	73	38.1	924	gy. m	SW.	3	S.	1.25	Do.
2218	Aug. 23	10.41 a. m.	39 46 22	69 29 00	72	74	38.8	948	gy. m	SW.	2	SE. by S.	1.75	
2219	Aug. 23	1.36 p. m.	39 46 22	69 29 00	72	74	38.8	948	gy. m	SW.	2	SE. by S.	1.75	
2220	Aug. 23	4.18 p. m.	39 43 30	69 23 00	75	74	38.3	1,054	gy. m	SW.	3	SE. by S.	1.5	
2221	Sept. 6	9.01 a. m.	39 05 30	70 44 30	77	75	36.9	1,525	gy. oz.	WSW.	2	SW. ½ S.	1.25	
2222	Sept. 6	2.20 p. m.	39 03 15	70 50 45	74	73	36.9	1,537	gy. oz	WSW.	3	SW. ¼ S.	2	
2223	Sept. 7	5.07 a. m.	37 48 30	69 43 30	79	75	36.4	2,516	glob. oz.	NW.	3	SE.	2	
2224	Sept. 8	8.31 a. m.	36 16 30	68 21 00	78	79	36.8	2,574	glob. oz.	NW.	2	W.	3.5	
2225	Sept. 9	5.47 a. m.	36 05 30	69 51 45	77	78	36.7	2,512	yl. oz	WSW.	2	SW. ½ S.	2.5	
2226	Sept. 10	5.06 a. m.	37 00 00	71 54 00	78	80	36.8	2,045	glob. oz	SW.	4	S.	1	
2227	Sept. 10	12.24 p. m.	36 55 23	71 55 00	81	82	36.8	2,109	glob. oz	SW.	3	SSW.	2	Lost trawl.
2228	Sept. 11	5.10 a. m.	37 25 00	73 06 00	77	77	36.8	1,582	br. m	SW.	3	S.	2	L. B. T.
2229	Sept. 11	4.12 p. m.	37 38 40	73 16 30	79	75	37.7	1,423	glob. oz	SW.	2	W. ½ N.	2	Do.
2230	Sept. 12	4.37 a. m.	38 27 00	73 02 00	75	75	36.8	1,168	gy. oz	WSW.	2	W.	1.5	Do.
2231	Sept. 12	9.42 a. m.	38 29 00	73 09 00	77	75	36.8	965	gy. oz	W.	3	NW.	1.5	Do.
2232	Sept. 12	2.48 p. m.	38 37 30	73 11 00	72	74	42.8	243	gn. m	NE.	4	NNE.	1.5	Do.
2233	Sept. 12	4.16 p. m.	38 36 30	73 06 00	69	73	39.2	630	gn. m	NE.	5	NNE.	1.5	Do.
2234	Sept. 13	4.30 a. m.	39 09 00	72 03 15	71	69	38.6	810	gn. m	ENE.	3	NE. by N.	1.75	Do.
2235	Sept. 13	7.33 a. m.	39 12 00	72 03 30	76	72	38.8	707	gn. m.	NE.	4	NE. by E.	1.25	Do.
2236	Sept. 13	9.49 a. m.	39 11 00	72 08 30	68	72	39.5	636	gn. m	NNE.	4	N. by E.	1.5	Do.
2237	Sept. 13	11.42 a. m.	39 12 17	72 09 30	70	72	39.5	520	gn. m	NNE.	4	SW.	1.5	Do.

2238	Sept. 13	2.26 p. m.	39 06 00	72 10 00	71	72	38.7	904	gy. m.	N.	5	NNW.	1.75	Do.
2239	Sept. 26	5.05 a. m.	40 38 00	70 29 45	62	62	....	32	gn. m.	NNE.	5	SSW.	1	Do.
2240	Sept. 26	7.29 a. m.	40 27 30	70 29 00	62	61	....	44	gn. m.	NNE.	6	SSW.	1	Do.
2241	Sept. 26	9.20 a. m.	40 21 00	70 29 15	63	63	51.4	50	gn m.	NE.	6	SW.	1	Do.
2242	Sept. 26	11.33 a. m.	40 15 30	70 27 00	63	63	51.4	58	gn. m	NE.	6	SW.	1	Do.
2243	Sept. 26	1.13 p. m.	40 10 15	70 26 00	65	64	52.4	63	gn. m	NE.	6	SW.	1	Do.
2244	Sept. 26	3.11 p. m.	40 05 15	70 23 00	66	71	52.9	67	gn. m. s	NE.	6	SW.	1	Do.
2245	Sept. 26	4.50 p. m.	40 01 15	70 22 00	61	61	50.9	98	gn. m. bk. s	NE.	6	WNW.	1	Do.
2246	Sept. 26	6.42 p. m.	39 56 45	70 20 30	64	71	48.8	122	gn. m	NE.	6	NE. by N.	1.25	Do.
2247	Sept. 27	4.57 a. m.	40 03 00	69 57 00	61	70	51.9	78	gn. m. s	E.	3	ESE.	.5	Do.
2248	Sept. 27	6.50 a. m.	40 07 00	69 57 00	64	70	52.4	67	gn. m. bk. s	E.	3	N. by E.	.75	Do.
2249	Sept. 27	8.24 a. m.	40 11 00	69 52 00	64	70	51.4	53	gn. m. fne. s.	E.	4	E.	1	Do.
2250	Sept. 27	10.04 a. m.	40 17 15	69 51 45	63	68	51.4	47	gn m. fne. s.	E.	4	E.	.75	Do.
2251	Sept. 27	12.02 p. m.	40 22 17	69 51 30	62	65	50.9	43	gn. m. fne. s	E.	3	NNE.	.5	Do.
2252	Sept. 27	1.46 p. m.	40 28 00	69 51 00	62	63	50.3	38	gn. m. fne. s	SE.	2	NNE.	.5	Do.
2253	Sept. 27	3.11 p. m.	40 34 30	69 50 45	61	61	52.9	32	gy. s. bk. sp	E.	2	NNE.	.75	Do.
2254	Sept. 27	4.39 p. m.	40 40 30	69 50 30	61	61	54.4	25	gy s. bk. sp	E.	2	NNE.	.75	Do.
2255	Sept. 27	6.10 p. m.	40 46 30	69 50 15	61	60	55.9	18	fne. s. bk. sp.	E.	1	NNE.	.75	Do.
2256	Sept. 28	5.42 a. m.	40 38 30	69 29 00	62	61	52.9	30	yl. s.	SSW.	2	SSE.	1	Do.
2257	Sept. 28	7.17 a. m.	40 32 20	69 29 00	62	61	51.9	33	yl s. bk. sp	SW.	2	S. by W.	1	Do.
2258	Sept. 28	8.34 a. m.	40 26 00	69 29 00	63	61	51.2	36	gy. s. bk. sp	SW.	2	S. by W.	.75	Do.
2259	Sept. 28	9.56 a. m.	40 19 30	69 29 10	64	61	50 2	41	gy. s. bk. sp	SW.	2	S. by W.	.75	Do.
2260	Sept. 28	11.13 a. m.	40 13 15	69 29 15	68	65	50.2	46	gy. s	SW.	3	S. by W.	.75	Do.
2261	Sept. 28	12.52 p. m.	40 04 00	69 29 30	69	66	53.9	58	gy. s. bk. sp	SW.	4	S. by W.	.75	Do.
2262	Sept. 28	2.51 p. m.	39 54 45	69 29 45	72	67	41.6	250	gn. m. s	SW.	4	S. by W.	.75	Do.
2263	Oct. 18	1.06 p. m.	37 08 00	74 33 00	67	66	....	430	gn. m.	W.	5	SSE.	1	Do.
2264	Oct. 18	2.37 p. m.	37 07 50	74 34 20	67	66	46.8	167	gy. s	W.	5	WSW.	1	Do.
2265	Oct. 18	3.47 p. m.	37 07 40	74 35 40	65	67	57.9	70	gn. m. gvl	W.	5	WSW.	1.5	Do.
2266	Oct. 19	6.00 a. m.	35 07 00	75 08 30	69	78	62.8	111	fne. s. bk. sp	NE.	5	N.	.5	S. B. T.
2267	Oct. 19	6.39 a. m.	35 08 50	75 07 20	67	79	72.8	68	gy. m.	NE.	5	NE.	2	Tgl. bar.
2268	Oct. 19	7.43 a. m.	35 10 40	75 06 10	67	79	71.3	68	gy. m.	NE.	5	NE.	2	Do.
2269	Oct. 19	8.46 a. m.	35 12 30	75 05 00	70	75	77	48	crs. gy. bk. s.	ENE.	4	WNW.	2	Do.
2270	Oct. 19	9.40 a. m.	35 14 15	75 07 00	70	75	76.3	32	fne. gy. s. bk. sp.	ENE.	4	W.	1.75	D. S. dredge.
2271	Oct. 19	10.45 a. m.	35 16 00	75 09 00	70	75	....	26	crs. gy. s. bk. sp.	ENE.	4	W.	2	S. B. T.
2272	Oct. 19	11.57 a. m.	35 20 10	75 14 00	69	75	....	15	gy. s. bk. sp	ENE.	3	WSW.	2	Do.
2273	Oct. 19	12.45 p. m.	35 20 30	75 17 30	69	72	72.3	17	gy. s brk. sh	ENE.	3	WNW.	2	Do.
2274	Oct. 19	1.22 p. m.	35 20 35	75 18 05	68	71	....	16	gy. s. brk. sh	NE.	2	WSW.	1.5	Dr. S. dredge.
2275	Oct. 19	1.43 p. m.	35 20 40	75 18 40	67	71	....	16	gy. s. brk. sh	NE.	3	WNW.	1	Dr. & M. B.
2276	Oct. 19	2.08 p. m.	35 20 45	75 19 15	67	71	....	15	gy. s. brk. sh.	NE.	3	WNW.	1	Do.
2277	Oct. 19	2.21 p. m.	35 20 50	75 19 50	67	71	....	16	gy. s. brk. sh	NE.	3	WSW.	.75	Do.
2278	Oct. 19	2.45 p. m.	35 20 55	75 20 20	67	71	....	16	gy. s. brk. sh	NE.	3	WSW.	.75	L. B. T.
2279	Oct. 19	3.36 p. m.	35 20 55	75 20 55	67	71	....	16	gy. s. brk. sh	NE.	3	WSW.	.75	Do.
2280	Oct. 19	4.15 p. m.	35 21 00	75 21 30	67	70	....	16	gy. s. brk. sh	NE.	3	WSW.	.75	Do.
2281	Oct. 19	4.35 p. m.	35 21 05	75 22 05	67	70	....	16	gy. s. brk. sh	NE.	3	WSW.	.75	Do.
2282	Oct. 19	5.13 p. m.	35 21 10	75 22 40	68	70	....	14	bk. s	NE.	3	NW. by W.	.75	Do.
2283	Oct. 19	5.41 p. m.	35 21 15	75 23 15	68	70	....	14	gy. s	NE.	3	N. by W.	.5	Do.
2284	Oct. 19	6.09 p. m.	35 21 20	75 23 50	67	70	....	13	crs. gy. s	NE.	3	WNW.	.5	Do.
2285	Oct. 19	6.40 p. m.	35 21 25	75 24 25	67	70	....	13	crs. gy. s	NE.	3	WNW.	.75	Do.
2286	Oct. 19	7.13 p. m.	35 21 30	75 25 00	67	70	....	11	crs. gy. s	NE.	2	WNW.	.5	Do.
2287	Oct. 20	6.15 a. m.	35 22 30	75 26 00	68	69	....	7	crs. gy. s	ESE.	2	E. by N.	.5	Do.
2288	Oct. 20	6.45 a. m.	35 22 40	75 25 30	68	69	....	7	crs. s. brk. sh	ESE.	2	E. by N.	.5	Do.
2289	Oct. 29	7.15 a. m.	35 22 50	75 25 00	70	69	....	7	crs. s. bk. sp	ESE.	2	E. by N.	.5	Do.

Dredging and Trawling Record of the United States Fish Commission steamer Albatross, Season of 1884—Continued.

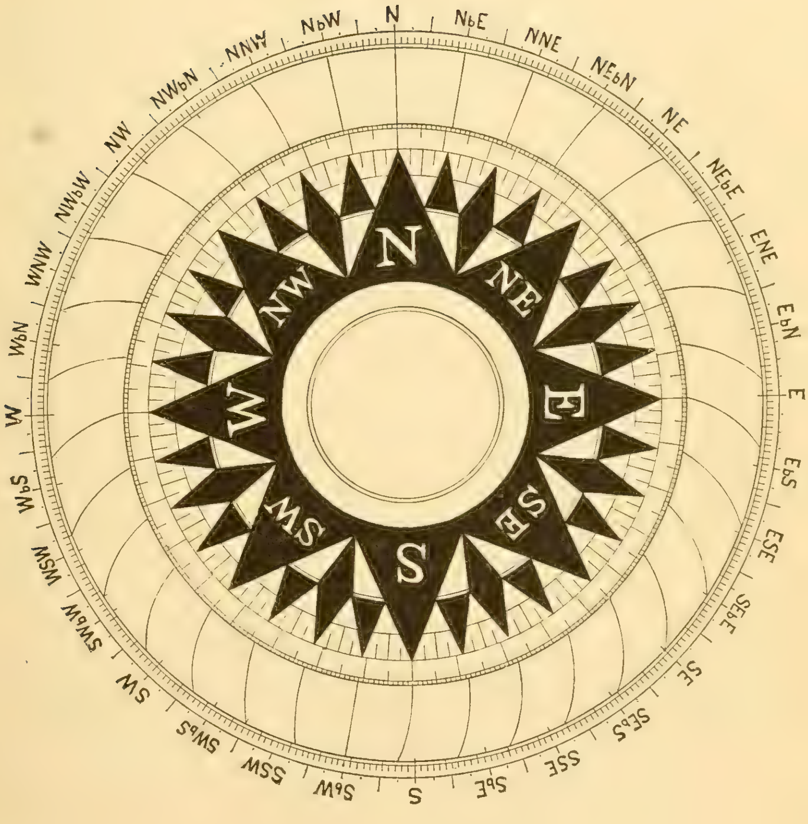
Serial No.	Date.	Time.	Positions.		Temperatures.			Depth in fathoms.	Character of bottom.	Wind.		Drift.		Instruments used.
			Latitude N.	Longitude W.	Air.	Surface.	Bottom.			Direction.	Force.	Direction.	Distance.	
	1884.		° ′ ″	° ′ ″									Miles.	
2290	Oct. 20	7.45 a. m.	35 23 00	75 24 30	70	69	....	9¼	s. brk. sh	ESE.	2	ENE.	.5	L. B. T.
2291	Oct. 20	8.45 a. m.	35 25 30	75 20 30	70	69	....	15	gy. s. brk. sh	ESE.	2	ENE.	.5	Do.
2292	Oct. 20	9.32 a. m.	35 27 20	75 16 30	72	70	....	17	gy. s. brk. sh	ESE.	2	E. by N.	.5	Do.
2293	Oct. 20	10.25 a. m.	35 29 10	75 12 30	71	71	....	18	crs. s. bk. sp	ESE.	2	E. by N.	.5	Do.
2294	Oct. 20	11.18 a. m.	35 31 00	75 08 30	73	71	....	19	crs. gy. s	ESE.	2	E. by N.	.5	Do.
2295	Oct. 20	12 03 p. m.	35 32 41	75 04 30	76	73	....	22	crs. gy. s	ESE.	2	E. by N.	.5	Do.
2296	Oct. 20	1.15 p. m.	35 35 20	74 58 45	75	71	....	27	crs. gy. s	SE.	2	E. by N.	.5	Do.
2297	Oct. 20	2.18 p. m.	35 38 00	74 53 00	75	73	....	49	bk. m. brk. sh	SE.	1	E. by N.	.75	Do.
2298	Oct. 20	2.55 p. m.	35 39 00	74 52 00	74	73	....	80	bk. m. brk. sh	SE.	1	E. by N.	.75	Do.
2299	Oct. 20	3.50 p. m.	35 40 00	74 51 30	74	73	....	296	bk. m	SE.	1	E. by N.	.75	Do.
2300	Oct. 20	5.20 p. m.	35 41 30	74 48 30	71	71	....	671	bk. m	SE.	1	E. by N.	1	Do.
2301	Oct. 21	6.10 a. m.	35 11 30	75 05 00	73	77	75	59	crs. s. bk. sp	SE.	1	NNE.	.5	Tgl. bar.
2302	Oct. 21	6.45 a. m.	35 14 00	75 03 00	74	77	71.4	49	s. co	ESE.	2	NE.	.25	Do.
2303	Oct. 21	7.11 a. m.	35 17 00	75 01 00	74	77	....	41	fne. gy. & bk. s	ESE.	2	NE.	.25	S. B. T.
2304	Oct. 21	7.40 a. m.	35 19 00	74 58 00	74	77	....	37	fne. gy. & bk. s	ESE.	2	E.	.5	Do.
2305	Oct. 21	8.36 a. m.	35 23 00	74 51 30	77	79	66.2	58	fne. gy. & bk. s	ESE.	2	E.	.5	Do.
2306	Oct. 21	11.00 a. m.	35 21 30	74 52 00	76	79	41.7	322	gy. m	ESE.	2	E.	.5	L. B. T.
2307	Oct. 21	4 11 p. m.	35 42 00	74 54 30	76	70	57.3	43	gy. & bk. s	ESE.	2	NE.	1	Do.
2308	Oct. 21	5.17 p. m.	35 43 00	74 53 30	72	71	....	45	gy. & bk. s	SE.	1	NE.	1	Do.
2309	Oct. 21	6.08 p. m.	35 43 30	74 52 00	72	71	....	56	gy. s. brk. sh	SE.	1	NE.	.5	Do.
2310	Oct. 21	6.59 p. m.	35 44 00	74 51 00	76	71	....	132	bk. m. fne. s	SE.	1	NE.	.5	Do.

Table of Serial Temperatures, 1884.

Serial No.	Date.	Position. Latitude N.			Position. Longitude W.			Depth.	Temperature. Air.	Temperature. Surface.	Temperature at— 25 fathoms.	50 fathoms.	100 fathoms.	200 fathoms.	300 fathoms.	400 fathoms.	500 fathoms.	600 fathoms.	700 fathoms.	800 fathoms.	900 fathoms.	1,000 fathoms.	1,100 fathoms.	1,200 fathoms.	1,300 fathoms.	Bottom.
	1884.	°	′	″	°	′	″	Fathoms.																		
Hyd. 46	Jan. 24	17	51	00	65	08	25	2,423	80	77	77	77	77	60	51											39.1
Hyd. 47	Jan. 24	17	46	30	65	10	25	1,482	78	77	77	78	67			45			40		40					38.8
Hyd. 57	Jan. 25	17	49	06	65	29	00	2,188	77	77	77	77	67	59			43				40					38.8
Hyd. 62	Jan. 25	17	32	40	65	52	20	2,017	77	77	77.5	78	66.3	58.5	48		44				40	40			40	
Hyd. 64	Jan. 26	16	59	00	65	19	20	2,543	76	77	77.5	77	65.3		62.5											
Hyd. 66	Jan. 26	16	28	00	64	42	30	2,192	78	77	77.8	76	65	55	47											39.8
Hyd. 71	Jan. 27	15	44	10	63	42	10	950	76	77	78	77.3	67	54.5												39.8
Hyd. 80	Jan. 28	13	56	35	63	02	00	684	75	77	77	72.5	61													39.5
Hyd. 82	Jan. 28	13	29	00	62	42	40	1,051	80	77					44.5											39.3
Hyd. 83	Jan. 28	13	23	00	62	34	15	1,686	77	78	76	68	61.3	50	45	43		40.5	40	40		39.5				39.5
2119	Jan. 29	11	48	50	62	17	30	1,140	75	77	75	68.5														39.3
Hyd. 116	Feb. 5	14	21	44	63	58	45	1,615	78	77	77.5	72	62													39.3
Hyd. 120	Feb. 6	16	01	00	65	56	20	2,492	76	77	77.5		64.5													39.8
Hyd. 121	Feb. 6	16	36	20	66	41	00	2,501	76	77	77	77	67	55	47.8											39.5
Hyd. 123	Feb. 7	15	49	00	67	36	40	2,616	76	77	77.3	77.3	67	55												
Hyd. 124	Feb. 7	15	02	00	67	13	20	2,747	80	77	77.8	78	66.5	53					40.5	39.8	39.5					
Hyd. 127	Feb. 8	13	25	04	66	25	00	2,844	77	77	77.8	77.8	55.5													
Hyd. 128	Feb. 8	12	54	40	66	11	10	2,768	81	78	77.5		61.3													39.5
Hyd. 133	Feb. 9	11	33	20	66	19	00	553	77	75	70.5	65	58	48.5												40.8
Hyd. 134	Feb. 9	11	18	50	66	24	20	656	79	76	71.8	65	58													40
Hyd. 135	Feb. 9	11	05	00	66	30	00	239	78	76	71	64.5														49.3
Hyd. 139	Feb. 9	11	01	00	67	14	15	695	75	75							40.5									
Hyd. 145	Feb. 10	11	52	00	68	35	46	630	78	76	76	68.5	59.8	49.8												
Hyd. 150	Feb. 18	11	56	00	68	56	00	733	77	76	76	66	63													39.6
Hyd. 151	Feb. 18	11	50	45	68	56	30	738	77	76	75	66														39.6
Hyd. 152	Feb. 18	11	40	25	68	57	30	321	76	75				50												45.2
2126	Feb. 19	13	17	45	70	01	00	1,701	78	77	76	66.5	65.5		47											39.3
Hyd. 162	Feb. 19	13	40	20	70	10	45	2,694	75	76	76	69	62	53	46											39.6
Hyd. 165	Feb. 20	15	55	00	71	03	00	2,209	76	77	76	74	67.5		47											39.6
Hyd. 166	Feb. 20	16	42	00	71	18	30	2,028	76	77			66		54											40.1
Hyd. 170	Feb. 21	17	48	00	72	12	20	2,434	77	77	77.5	77	69		51											
Hyd. 171	Feb. 21	18	01	30	72	23	00	1,929	81	79	77	76	67		51											39.6
Hyd. 172	Feb. 21	18	07	00	72	29	00	1,538	80	79	77.5	77	67		50											39.6
Hyd. 179	Feb. 22	17	36	30	72	56	00	2,423	78	77		77	70.5		51											39.7
Hyd. 180	Feb. 22	17	45	30	73	04	00	2,391	79	77					51.5											
Hyd. 188	Feb. 23	17	51	40	74	36	30	894	75	77																

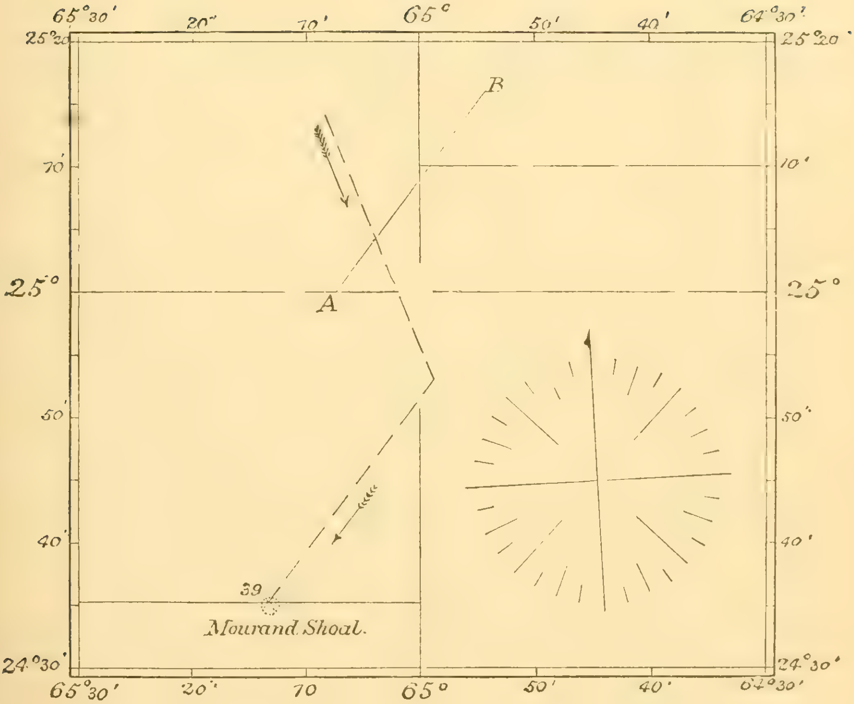
Table of Serial Temperatures, 1884—Continued.

Serial No.	Date.	Position. Latitude N.	Position. Longitude W.	Depth.	Temperature. Air.	Temperature. Surface.	Temperature at— 25 fathoms.	50 fathoms.	100 fathoms.	200 fathoms.	300 fathoms.	400 fathoms.	500 fathoms.	600 fathoms.	700 fathoms.	800 fathoms.	900 fathoms.	1,000 fathoms.	1,100 fathoms.	1,200 fathoms.	1,300 fathoms.	Bottom.
	1884.	° ′ ″	° ′ ″	*Fathoms.*																		
Hyd. 190	Feb. 23	17 33 30	74 45 00	955	78	77																
Hyd. 197	Feb. 24	18 45 00	74 32 40	1,347	78	77	77.5	76	72		61											
Hyd. 198	Feb. 24	18 50 00	74 12 00	1,537	84	79	78	77	68.5		58											
Hyd. 199	Feb. 24	18 56 00	73 51 00	1,974	80	79	78	77.4	68.2		51.5											39.7
Hyd. 205	Feb. 25	19 40 00	74 42 00	1,923	77	77	78	74.6	66.7		54											39.7
2127	Feb. 25	19 45 00	75 04 00	1,639	78	77	77.6	76	69	61	54.2	47.5	43.5	40	39		39.7					
Hyd. 206	Feb. 25	19 43 21	75 15 30	1,745	76	77	77	76	71													39.7
Hyd. 215	Feb. 28	18 54 30	74 16 30	1,486	77	78	78.4	78	74.4		51											39.9
Hyd. 216	Feb. 28	18 32 30	75 06 00	870	78	78		78.4			52.4											39.7
Hyd. 217	Feb. 28	18 34 00	74 21 00	1,015	79	78	77.8	77.6	68.7		49.7											39.7
Hyd. 346	Mar. 23	9 46 00	76 18 30	255	81	82		72.2	62.9													
Hyd. 353	Mar. 24	9 44 40	77 56 00	550	79	79	76	72.2	61.1													41.8
Hyd. 354	Mar. 24	9 47 00	78 09 30	630	79	78	78.7	72.5	61.4	51.6												
Hyd. 355	Mar. 24	9 48 00	78 24 00	1,017	79	79		72.1	61.4	52												
Hyd. 363	Mar. 25	9 45 15	79 34 00	370	80	79		75	56.5													
Hyd. 371	Apr. 3	11 20 00	80 42 10	1,832	80	79	78	74	63.8	51.6	46.6	44.8	40.4	40.5	39.5	39.6	39.5	39.2				39.3
2151	Apr. 10	15 28 39	80 36 00	653	79	78	78.8	77.8	67.9	55.3	47.8	42.7	41.4									40.2
Hyd. 419	Apr. 14	23 48 14	84 06 55	1,356	79	79	78.6	77.9	67.9	57.1	51.4	44.6		40.9	40.1	40		39.8				39.7
2172	July 20	38 01 15	73 44 00	568	76	76	58.8	55.4	51	45.1	40.7	40										38.6
2173	July 21	37 57 00	72 34 00	1,600	70	68	53	51.7	51.7	51.7	39.7	39.7	39.5	38.7	38.7	38.7	38.1	38.1				37
2175	July 22	39 33 00	72 18 30	452	69	68	50.5	51.3	50.6	44.1	40.6	40.2										40.7
Hyd. 533	July 23	39 23 45	71 43 00	992	70	69	57	52.8	50.7	44.2	40.7	40.2	40	39.6	38.7	38.7	38.6					38.6
Hyd. 544	Aug. 3	39 55 00	71 07 00	221	71	68	64.3	51.8	51.8													49.3
Hyd. 545	Aug. 4	39 47 00	70 16 30	784	74	72	61.1	52.6	52.2	45.9	40.9	39.6	39.3	39.2								
2197	Aug. 6	39 56 30	69 43 30	84	77	74	49.8	52.8	52.3													52.3
Hyd. 549	Aug. 20	39 34 00	71 34 30	925	75	74	66.2	54.8	51.2	43.8	40.6	40.1	40.6	39.2	38.5	39						38.6
Hyd. 552	Aug. 23	39 40 05	69 23 00	1,098	75	74	63.2	55.9	52.5	44.3	40.7	39.3	40.6	39.2	39.1	38.6		38.8				38.3
Hyd. 553	Sept. 7	37 41 00	69 15 16	2,704	79	81	82	79.8	72.7	57.3	44	45.6	40.5	39.6	39.6	39.5	39	38.6				36.3
2224	Sept. 8	36 16 30	68 21 00	2,574	79	80	79.8	77.1	67.1	64.8	64.6	63.8	52.5	44.9	41	40.2	39.5	39.5				36.8
2225	Sept. 9	36 05 30	69 51 45	2,512	77	81	78.3	71.9	67.6	64.3	64.8	60	51.1	44.7	41.4	40.2	39.6	39.2				36.7
2227	Sept. 10	36 55 23	71 55 00	2,109	81	82	82.2	77.1	71.4	65.2	62.8	57.7	52.7	42.5	40.4	39.3	39.2	39.1				36.8
Hyd. 554	Sept. 11	37 22 53	73 06 30	1,600	78	7[illegible]	76	63.2	63.8	48	46.3	39.7	39.4	39.3	39.1	38.8		38.7				36.8
Hyd. 556	Sept. 12	39 40 00	73 03 00	474	70	74	61.8	52.9	49.3	43.5	40.4											39.7
Hyd. 557	Sept. 13	39 08 30	72 12 30	851	66	72		66.8	53.5	43.1	40.6	39.7	39.2	39.1	38.7							38.7



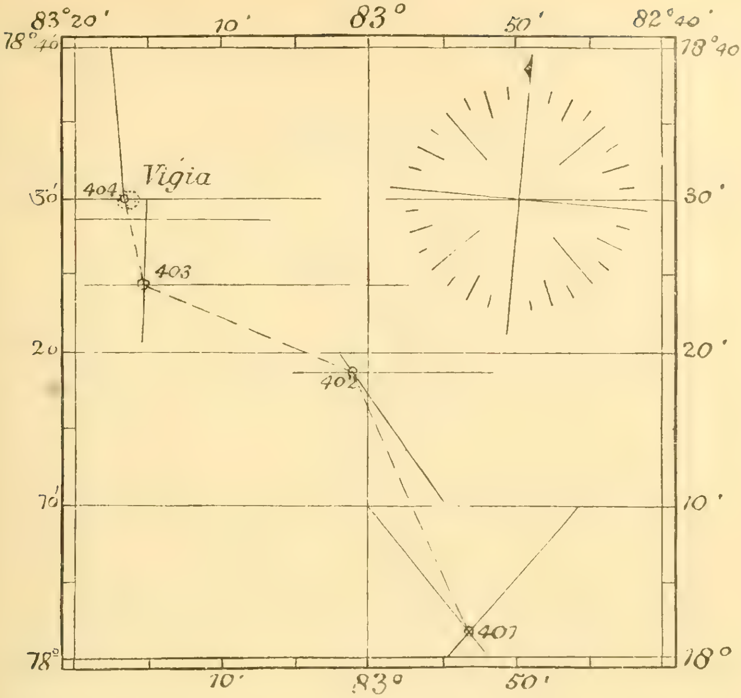
Steering-card. Gulf of Paria, February, 1884.

Case I.

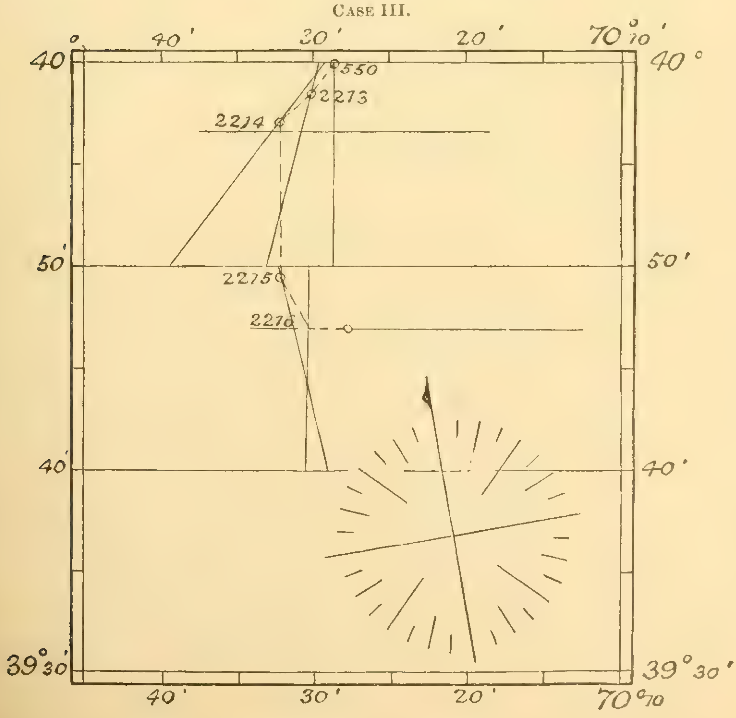


Illustrative case in navigation.

CASE II.



CASE III.



Illustrative cases in navigation.

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II.—REPORT ON THE WORK OF THE UNITED STATES FISH COMMISSION STEAMER FISH HAWK FOR TWO YEARS ENDING DECEMBER 31, 1884.

By Lieut. W. M. Wood, U. S. N.

I have the honor to submit the following general report on the operations of the Fish Commission steamer Fish Hawk while under my command, detailed reports having been made to you on the completion of each service.

On the 20th of November, 1882, I relieved Lieut. Z. L. Tanner of the command of the vessel at the navy-yard, Washington, D. C. For the rest of the winter we remained at the yard overhauling, refitting, and preparing for the spring hatching season.

On the 15th of March, 1883, under orders from you, we made a trip to the mouth of the Potomac in search of a whale reported ashore on Smith's Point, to inspect the station at Saint Jerome, and to see how the early fisheries on the Lower Potomac were coming on. We heard nothing of the whale, and having completed the remainder of the duty returned to Washington on the 18th March.

On the 23d of the same month loaded with freight for station at Battery Island, near Havre de Grace, Md., and leaving Washington on the 24th touched at Saint Jerome, and arrived at Battery Station on the 25th. Left the Battery on the 27th with steam-launch in tow; ran down to Baltimore and coaled ship. Left Baltimore on the 29th and arrived in Washington on the morning of April 1, having touched at Saint Jerome and some of the Potomac fisheries on the way round.

Having taken on board all our hatching outfit, and a quantity of stores, boats, &c., for the newly-established station at Fort Washington, Md., we got under way on the morning of April 12; touched and landed stores, &c., at Fort Washington, and then proceeded, by your instructions, to the mouth of Quantico Creek, Va., where the vessel was established for hatching the spawn of shad, herring, perch, &c. We remained there until May 7, when our station was changed to the neighborhood of Glymont, Md. We finished the hatching season of 1883 at this point and returned to the navy-yard at Washington on the 28th of May.*

*Table of results already submitted.

The freshwater hatching outfit was now unrigged and experimental apparatus for hatching the spawn of the Spanish mackerel and other floating eggs taken on board.

Under orders from you we got under way on June 4, 1883, for a cruise down the Potomac, west side of Chesapeake Bay from Potomac River to Cape Henry, and from Cape Charles to Cherrystone Inlet, for the purpose of locating the number, size, catch, &c., of the trap-nets fished along those shores.*

This part of the instructions having been completed by June 12, we then commenced the investigation of the Spanish-mackerel fisheries. Many attempts were made to hatch and keep alive the young of this fish, but without success. We had no difficulty in hatching the eggs, but found it impossible to keep them alive for more than a few hours. In my special report on this subject I have advanced the only theory I can give to account for this lack of success.

On July 13 the Fish Hawk was driven ashore, from her anchorage in Lynn Haven Bay, by a heavy northerly squall. She was floated again on the morning of the 18th without any injury whatever. This was the only interruption to the summer's work on the Spanish mackerel until we left the Chesapeake, August 17, for Wood's Holl, Mass., arriving at this place August 20.*

On August 22 left Wood's Holl with some of the scientific corps for a dredging trip to the south of Martha's Vineyard. Commenced work in latitude 40° 13′ north, longitude 70° 29′ west on the morning of the 23d and returned to Wood's Holl the following night.* On the 27th of August carried out another party on a dredging and trawling trip, returning to Wood's Holl the same night, and on the 30th got under way and proceeded to New Bedford. Remained in New Bedford, having boilers repaired, until September 4, when we returned to Wood's Holl.

September 6 got under way with scientific party for dredging trip on south side of Martha's Vineyard, returning to Wood's Holl same night.

On September 23 went to the assistance of the steamer Decatur H. Miller, ashore on the Middle Ground, in Martha's Vineyard Sound. Found the Coast Survey steamer Blake and revenue steamer Dexter fast to her, and by our united efforts soon got her afloat.

October 9 made a trawling and dredging trip to Menemsha Bight, returning to Wood's Holl the same night.

October 14 and 15 loaded with specimens, stores, &c., for transportation to Washington. Got under way on the 16th, touched at Newport for coal, and arrived at navy-yard, New York, on the 20th. Received here scientific outfit, specimens, &c., from the United States steamer Yantic, just back from her arctic trip, for transportation to Washington. Left New York on the 26th, having taken on board 100 live lob-

* Table of results already submitted.

sters, to be transplanted to the waters of the Chesapeake Bay, in the hope that they would stock that locality.

Arrived in Hampton Roads on the evening of October 27, and deposited 92 of the lobsters near the Ripraps. Reached the navy-yard, Washington, October 30, and at once began unloading and sending freight to National Museum, Smithsonian Institution, and Armory.

On the 12th of November, left Washington for Saint Jerome for the purpose of surveying and stocking the oyster-beds in Saint Jerome Creek. Completed this duty and returned to Washington on the 26th, where we remained for the balance of this year, repairing boilers and overhauling the ship.

Under orders to proceed to the Saint Mary's River, Florida, to see if anything could be done in the way of hatching shad in that locality, we left Washington March 8, 1884, and touching at Norfolk, Va., and Charleston, S. C., arrived at Fernandina, Fla., on the morning of March 18. Left the same day for Saint Mary's, Ga., where we got a river pilot and proceeded up the Saint Mary's River to King's Ferry, Fla., at which place we arrived March 19. We found very few fish being caught and none of them in good condition, as stated in my special report; so after remaining here until March 31, returned to Fernandina, by your orders, to await further instructions. Left Fernandina April 3, for Georgetown, S. C., touching at Savannah, Ga., and Charleston, S. C.

After investigating the shad fisheries in Winyaw Bay, with a view to the propriety of establishing a station there for future work, we left Georgetown, S. C., on April 7th, and arrived in Washington on the 10th.

On April 24, left Washington on a cruise of investigation to the various fishing points of the Potomac River and lower Chesapeake Bay, returning to Washington April 28.

May 1 we left Washington for hatching work on the Upper Potomac and located near Bryant's Point, where we remained collecting eggs until May 27. On the 14th of May we ran up to Washington to carry the United States Fisheries Association down the river to visit the fisheries, afterwards resuming our station at Bryant's Point.

June 23 we left Washington for Saint Jerome, with coal and ice on board for that station. Arrived there the following day, and having discharged the coal and ice commenced repairs on and made preparations to launch the large barge, which we were ordered to transfer from here to Battery Station, Havre de Grace.

Launched barge July 2 and started up the bay with it and a steam-launch, which was also to be transferred, in tow. Arrived in Baltimore July 3, where we were ordered to pick up a large scow for Battery Island. Left Baltimore July 5, arriving at the Battery the same day, when the barge, launch, and scow were turned over to Mr. Hamlen, in charge of station.

July 7 left Havre de Grace with freight and another launch in tow

for Saint Jerome Station. Dropped the launch at Saint Jerome early on the morning of the 8th, and then proceeded to Washington, arriving at the navy-yard on the evening of that day.

On the 9th began receiving freight for Wood's Holl. Left Washington July 15, and arrived in New York, July 17. Having received a number of stores for Wood's Holl left New York on the 20th, touched at Noank, Conn., to pick up a scow to be towed to Wood's Holl, arriving at the latter place on the evening of July 21.

July 23 made a dredging and trawling trip to Gay Head with the Secretary of the Navy and party on board. July 30 proceeded to New Bedford, where the vessel was hauled out to have the bottom cleaned and copper repaired. She was launched again on the 31st, and returned to Wood's Holl August 1. On August 19 carried scientific party on dredging and trawling trip to Hawes Shoal, returning to Wood's Holl the same night.

On the morning of August 22 received from the steamer Gate City the officers and crew of United States steamer Tallapoosa, sunk during the night in Vineyard Sound by collision with the schooner J. S. Lowell. As soon as possible the Fish Hawk got under way and visited the scene of the wreck. After picking up the steam-launch and taking the remainder of the crew off the schooner, as we could be of no further assistance, we returned to Wood's Holl.

August 25 made a trawling trip with scientific party to Menemsha Bight, returning to Wood's Holl the same night. On September 2 a party was carried to the mouth of Buzzard's Bay on a trawling expedition, returning the same day. September 8 a dredging trip was made, with some of the scientific corps on board, to Vineyard Sound, returning same day to Wood's Holl.

On October 14 commenced loading with specimens and other freight for transportation to Washington. Sailed from Wood's Holl October 16, arriving at navy-yard, New York, on the morning of the 17th. Received here another lot of lobsters for transfer to the mouth of the Chesapeake. Got under way, bound for Washington, on the 18th of October. Entered the bay on the evening of the 19th, deposited the lobsters off Back River Light, and reached Washington on the evening of October 20.

Left Washington again on November 2 for a cruise on the oyster-beds of the Chesapeake Bay. The investigations during this trip were carried on by means of the usual appliances, such as dredges, tangle-bars, trawls, &c., and in addition at each locality a submarine diver was sent down who examined the condition of the bottom. His reports thereon are embodied in the notes accompanying my special report on this subject. On one occasion I put on his suit myself, and went down to see how far he could depend on eyesight. With the water a little turbid, as it usually is in the shoal waters of the Chesapeake, I found

it impossible to see anything. His investigations, therefore, were mostly by feeling.

During this trip we worked principally in Tangier Sound and off Saint Jerome Creek. We visited Crisfield, Baltimore, and Annapolis, Md., returning to Washington, November 27, 1884.

Having applied to be relieved from duty in the Fish Commission, I was, on December 31, 1884, detached from the Fish Hawk; and on that day I turned her over to the next in rank, Ensign L. W. Piepmeyer, U. S. Navy.

WASHINGTON, D. C., *August* 10, 1885.

Trawling record of the U. S. F. C. steamer Fish Hawk, August 23, 1883.

No. of station.	Bearings.		Temperature of water.		Depth (fathoms).	Character of bottom.	Direction of wind.	Use of trawl.				
	Latitude north.	Longitude west.	Surface.	Bottom.				Time when put over.	Time going down (minutes).	Time remained down (minutes).	Time heaving in.	Fathoms of wire rope out.
	° ′	° ′	°	°								
1156	40 13	70 29	67	45	60	Mud	South	6 a. m	5	30	...	150
1157	40 14	70 29	70	45	62	Soft mud	...do	6.35 a. m	5	45	...	150
1158	40 16	70 31	67	45	62	Soft green mud	...do	8 a. m	5	45	...	180
1159	40 20	70 33	67½	44	55	Soft mud	South, light	10.15 a. m	5	30	...	......
1160	40 24	70 35	70	43	41	Black mud	...do	11.25 a. m	10	25	...	100
1161	40 28	70 37	69	44	45	...do	South, 2	12.45 p. m	5		...	125
1162	40 32	70 39	68	46½	45	...do	Southwest, 2	2.15 p. m	5	25	10	125
1163	40 35	70 41	71	46	31	Sand and mud	...do	3.25 p. m	5	20	5	......
1164	40 43	70 45	70	44	31	Mud	...do	5 p. m	5	20	6	100
1165	40 50	70 49	68	45	32	Gray sand	...do	6.25 p. m	5	25	5	100

Trawling record of the U. S. F. C. steamer Fish Hawk, August 23, 1883—Continued.

No. of station.	Specific gravities.			Specimens obtained.
	Surface.	Five fathoms.	Ten fathoms.	
1156	....	....	....	Phycis tenuis, 1; Citharichthys, 2.
1157	1.0234—70°	....	....	Phycis, 8; Merlucius bilinearis, 1.
1158	1.0235—67½°	1.0235—66½°	1.0236—67°	Phycis tenuis, many.
1159	1.0236—67½°	1.0238—67¼°	*1.0238—67°	Phycis, 8.
1160	1.0236—70°	1.0238—68°	1.0239—67½°	Phycis tenuis, Phycis chuss, Merlucius bilinearis, few; Glyptocephalus cynoglossus, 3; Paralichthys oblongus, few; Flounders, 2 specimens; Enchelyopus, 4.
1161	1.0236—69°	1.0238—68°	1.0238—68°	Phycis, 2; Flounders, 2; species Lophius piscatorius, 2; Enchelyopus, 4; Merlucius, unknown species.
1162	1.0236—68°	1.0238—66°	1.0240—66°	Paralichthys oblongus, 4; Flounders, 2 species, 5; Merlucius, 1; Phycis, few; Sculpin, 1; Enchelyopus, 2; Lophius, 2; unknown, 1.
1163	1.0234—71°	1.0232—70°	1.0232—69°	Lophius, 1; Sculpin, 1; Merlucius, few; Phycis, few, two species; Paralichthys, few; Flounders, 2 species.
1164	1.0236—70°	1.0234—68°	1.0234—68°	Glyptocephalus, 2; Merlucius, 8; Phycis, 8; Sculpin, 1; Paralichthys, few; Flounders, few.
1165	1.0234—68°	1.0248—65°	1.0250—58°	

* Fifteen fathoms.

III.—REPORT ON THE WORK OF THE UNITED STATES FISH COMMISSION STEAMER LOOKOUT FOR THE YEAR ENDING DECEMBER 31, 1884.

By Mate James A. Smith, U. S. N., Commanding.

On January 1, 1884, by order of the Navy Department, I was detached from duty on the U. S. Fish Commission steamer Fish Hawk and ordered to assume the command of this vessel, the Lookout. The vessel was then on the marine railway at the navy-yard, Washington, D. C., undergoing extensive repairs, the superintendence of which I took in charge, under instructions from time to time from Assistant Commissioner T. B. Ferguson. On April 30 the vessel was launched, and on May 17 got up steam and made a short trial trip down the river as far as Fort Washington and returned to the navy-yard. Machinery worked well, but found some slight alterations were required to perfect the vibration of the cylinders.

May 29, at 5.45 p. m., left navy-yard, Washington, D. C., with Assistant Commissioner T. B. Ferguson on board, bound to Saint Jerome Station, Maryland, arriving there at 12.10 p. m. of the 30th. Took on board a small boiler and returned to navy-yard on the 31st, arriving there at 5.30 p. m.

June 7, Assistant Commissioner T. B. Ferguson came on board. Got under way from navy-yard at 5.30 p. m., and proceeded down the Potomac River, with launch No. 68 in tow, bound to Saint Jerome Station; arrived there at noon of the 8th, and delivered the launch to the superintendent of the station; at 3 p. m. proceeded up Chesapeake Bay, bound to Battery Station, Havre de Grace, Md., arriving there at 9.15 a. m. of the 9th. Assistant Commissioner Ferguson left the ship. At 3.30 p. m. left Battery Station with a seine-boat in tow bound to Saint Jerome Station, arriving there at noon on the 10th; delivered seine-boat to the superintendent of the station, and at 3 p. m. left the station and proceeded up the Potomac River to navy-yard, Washington, D. C., arriving at 8.30 a. m. of the 11th, and continued the refitting.

June 21 Assistant Commissioner T. B. Ferguson came on board; at 5.20 p. m. left navy yard and proceeded down the Potomac River, bound to Saint Jerome Station, arriving there next day, and returned to navy-yard, Washington, D. C., at 6 p. m. of the 25th.

June 27 left navy-yard at 5.45 p. m., with Assistant Commissioner T. B. Ferguson on board, bound to Saint Jerome Station. Communicated with U. S. Fish Commission steamer Fish Hawk, in Cornfield Harbor, Point Lookout, Md., on the 28th, and returned to navy-yard, Washington, D. C., at 8.30 a. m. on the 29th.

July 3, by order of the Chief of Bureau of Steam Engineering, a board of four engineer officers of the Navy came on board in order to test the working of the machinery and speed of propeller. At 8 a. m. got under way from navy-yard and proceeded down the river; made three round trips from Geisborough Point to Marshall Hall, and returned to navy-yard at 4.40 p. m.; made fast to wharf; carpenters and plumbers at work until the 9th.

July 10, at 5.30 p. m., left navy-yard, with Assistant Commissioner T. B. Ferguson on board, and proceeded down the Potomac River, bound to Saint Jerome Station, arriving there at 10 a. m. on the 11th. Assistant Commissioner went on shore and inspected the station. On July 13, at 8 a. m., got under way and steamed across the bay, bound to Crisfield, Md.; arrived there at noon. Left again at 1 p. m., and proceeded down Tangier Sound and Chesapeake Bay to Cherrystone, Va., arriving there at 6 p. m. July 14 left Cherrystone at 8 a. m., interviewed pound-net fishermen in regard to Spanish mackerel as far as Fishermen's Inlet, then proceeded to Hampton Roads, Virginia, arriving at 3 p. m. July 15, during forenoon, steamed up to Norfolk, Va. Coaled and watered ship. Took on board a steam-pump and some lumber for Saint Jerome Station. July 16 got under way at 8 a. m., bound to Saint Jerome Station, arrived there at 5.30 p. m., delivered steam-pump and lumber to superintendent of station. July 18 left Saint Jerome Station, proceeded up the bay, bound to Baltimore, Md.; arrived at noon of the 19th and came to anchor.

July 25 Assistant Commissioner T. B. Ferguson came on board. At 3.30 p. m. left the harbor and proceeded down the bay, bound to Saint Jerome Station; arrived there at 3 p. m. on the 26th. July 27, at 5 a m., got under way and steamed down the bay, bound to Hampton Roads, Virginia. At 2.30 p. m. arrived and anchored in Hampton Creek, Virginia. July 28 got under way at 6 a. m., steamed across Chesapeake Bay and examined all the pound-nets between Fishermen's Inlet and Hungers Creek. At 4.30 p. m. anchored in Cherrystone Inlet, Virginia. July 30 left Cherrystone Inlet and steamed across the bay, bound to Hampton Roads; while on the way over lost one blade of the propeller. At 4.30 p. m. arrived at Norfolk, Va., and made fast to wharf of W. A. Graves, and prepared ship to be hauled out on marine railway. August 1 ship was hauled out on Graves's marine railway and put on spare propeller.

August 2, at 7.30 a. m., launched ship. United States local inspectors came on board and examined boiler; got a cold-water pressure of 115 pounds. At 4.45 p. m. proceeded down Elizabeth River and anchored

in Hampton Roads, Virginia. August 3, at 11.30 a. m., left Hampton Roads, Virginia, bound to Saint Jerome Station; arrived there at 7 p. m. August 4, at 6 a. m., got under way bound to navy-yard, Washington, D. C., arriving at navy-yard at 4 p. m.

August 5, by order of the Chief of Bureau of Steam Engineering, a board of four engineer officers of the Navy came on board to test the working of the engines and speed of the vessel with the spare wheel put on at Norfolk, Va. At 4.45 p. m. returned to navy-yard.

August 6 left navy-yard bound to Saint Jerome Station; and arrived at 10 a. m. on the 7th. August 8 got under way from Saint Jerome Station and proceeded down the bay, bound for New York. At 7 p. m., anchored in Hampton Roads, Virginia; wind squally and strong from NE. From August 8 to 15 were wind-bound in Hampton Roads, Virginia. At 3.45 a. m. of the 15th proceeded out of Hampton Roads, Virginia, bound to Delaware Breakwater. At 11.30 a. m., when about 10 miles off Chincoteague light-house, lost one blade of the propeller. Returned to Norfolk, Va., arriving there at 8 a. m. on the 16th. From August 16 to 21 were waiting to go on marine railway. At 1 p. m. of the 21st hauled vessel out on Graves's marine railway and put on a new propeller received at navy-yard, Washington, D. C. August 22 launched ship, steamed down to Hampton Roads, and anchored at 5 p. m. August 23, at 9.30 a. m., left Hampton Roads, Virginia, bound to New York; arrived there at 4 p. m. of the 24th.

August 25, at 4 p. m., Assistant Commissioner T. B. Ferguson came on board. Got under way and proceeded up East River bound to Wood's Holl, Mass., stopping at New London, Conn., and Newport, R. I., *en route;* arrived at Wood's Holl, Mass., at 6.30 p. m., August 28. August 30, at 8.30 a. m., left Wood's Holl bound to New Bedford, Mass. At 3.50 p. m. returned to Wood's Holl with spar in tow for use at the Fish Commission station.

September 3, at 9 a. m., Prof. G. B. Goode and scientific party came on board. Left Wood's Holl and steamed out to No Man's Land, made several hauls with the dredge, and spent some time fishing for sharks. At 5.15 p. m. returned to Wood's Holl.

September 5, at 10.15 a. m., left Wood's Holl bound to Mattapoisett, Mass., with Assistant Commissioner T. B. Ferguson on board; arrived there at 11.30 a. m. General W. T. Smith came on board, and after some time spent in conference and examination of plans of work at Battery Station, Maryland, returned to Wood's Holl, arriving there at 6.30 p. m. From September 6 to 10 were engaged in painting and cleaning ship.

September 10, at 9.25 a. m., got under way from Wood's Holl bound to New York; arrived there at 5 p. m. on the 11th. Reported for duty to E. G. Blackford, fish commissioner of the State of New York, to assist him in making an investigation of the oyster-beds in Long Island

Sound, Prince's Bay, Kill von Kull, and Hudson River; made daily trips to these points, and was engaged on that duty until September 25.

September 26, at 8.45 a. m., left New York and proceeded to Patchogue, Long Island, to assist Dr. Tarleton H. Bean in making a collection of fishes in Great South Bay, the vessel being used to transport his party from point to point. Arrived at Patchogue, Long Island, at 5.30 p. m. Was engaged on the above duty until October 7.

October 8 left Patchogue, Long Island, at 5 a. m., bound to Wood's Holl, Mass., arriving there at 9 p. m. October 9, 10, and 16 engaged with vessel in towing scow to Tarpaulin Cove and back, with gravel for grounds at station.

October 17, at 7.30 a. m., took steam-launch Cygnet and cat-boat Edna in tow, and proceeded out of the harbor bound to Battery Station, Havre de Grace, Md., *via* Long Island Sound to New York, thence by Raritan and Chesapeake and Delaware Canals, stopping *en route* at New London, Conn., New Brunswick, N. J., Bordentown, N. J., and Delaware City, Del.; arrived at Battery Station at 1.30 p. m. of October 23, and delivered launch Cygnet and cat-boat Edna to superintendent of station. At 1.45 p. m. left Battery Station and proceeded down Chesapeake Bay bound to Baltimore, Md. At 5.15 p. m. arrived and made fast to Clark's machine-shop wharf. October 23 to 29 engaged in making some necessary repairs to boiler.

November 2, at 10.30 a. m., left Baltimore, Md., bound to Battery Station, arriving at that place at 2.45 p. m. November 4 got under way from Battery Station at 6 a. m., and proceeded to Baltimore, Md., arriving there at 10.30 a. m.

November 5, at 6 a. m., left Baltimore, Md., proceeded down the bay bound to Saint Jerome Station; at 8.20 a. m. put into Annapolis, Md., and took on board Assistant Commissioner T. B. Ferguson, arriving at Saint Jerome Station at 4.30 p. m. November 6, at 6 a. m., got under way from station and steamed across the bay bound to Cristield, Md.; arrived at 9 a. m., and communicated with U. S. Fish Commission steamer Fish Hawk. November 7, at 8 a. m., got under way and steamed out to the oyster-bed in Tangier Sound and made several hauls of the oyster dredge on the natural beds to ascertain the quantity of oysters and shells dredged up over a measured distance. U. S. Fish Commission steamer Fish Hawk was at work in the immediate vicinity. At 5 p. m. finished dredging and returned to Crisfield, Md. November 8 left Crisfield, Md., at 7.45 a. m. bound to navy-yard, Washington, D. C., arriving there at 9.40 a. m. of the 9th.

November 11 took on board a new composition propeller. At 9.45 a. m. left the navy-yard and proceeded down the river, bound to Baltimore, Md. At 2.30 a. m. of the 12th the disabled schooner American Coaster asked for assistance. Took her in tow opposite Annapolis and proceeded for Baltimore, Md.; arrived there at 10.30 a. m. At 11.30

hauled ship out on William Skinner's marine railway, and put on new composition propeller, received at navy-yard, Washington, D. C.

November 13 launched ship, and at noon left Baltimore, Md., bound to Battery Station, Havre de Grace, Md. November 15, at 6.30 a. m., left Battery Station with lighter in tow bound to Saint Jerome Station. At 5.30 p. m. arrived and delivered lighter to superintendent of station. November 16 started from Saint Jerome Station bound to Baltimore, Md.; arrived at 2.30 p. m.

November 17, at 2 p. m., Assistant Commissioner T. B. Ferguson came on board. Steamed out of the harbor and proceeded down the bay. At 9 p. m. anchored in Patuxent River, Maryland. November 18 got under way at 7 a. m. and proceeded down the bay, passed the U. S. Fish Commission steamer Fish Hawk, at work on oyster-beds in the vicinity of Saint Jerome Creek. At 2.30 p. m. anchored in Smith's Creek, Maryland. November 19, at 11.45 a. m., left Smith's Creek and proceeded across the bay bound to Crisfield, Md.; took soundings on oyster-beds in Tangier Sound in the vicinity of Kedges Straits. At 4.30 p. m. anchored in Crisfield Harbor, Maryland. November 20 got under way from Crisfield, Md., at 2 p. m.; proceeded up Tangier Sound and through Hooper's Straits. Came to anchor in Patuxent River at 6.20 p. m. November 21, at 6.10, got under way and steamed down the bay to Saint Jerome Station. Received on board three steam-pumps for transfer to Battery Station. At 9.40 a. m. left Saint Jerome Station bound to Battery Station, Havre de Grace, Md. At 2.15 communicated with U. S. Fish Commission steamer Fish Hawk, coming down the bay. At 8.15 p. m. arrived at Battery Station. Assistant Commissioner T. B. Ferguson left the ship. November 22 to December 1, at Battery Station having extension built to deck-house to be used during the coming spring as a hatching-room. December 1 to 3, were engaged in towing lighter to and fro from Havre de Grace, Md., with coal for Battery Station. December 3 to 23, at Battery Station, finishing deck-house. December 18 to 23, bay completely frozen over.

December 23, at 8 a. m., left Battery Station bound to Baltimore, Md. Succeeded in cutting a track through the loose ice and at midnight anchored at Turkey Point. December 24, at 6.45 a. m., steamed ahead through an opening in the ice, and arrived at Baltimore, Md., at 11.15 a. m. From December 24 to 31, made fast to Waters' wharf, Baltimore, Md.

STEAMER LOOKOUT,
Baltimore, Md., December 31, 1884.

IV.—WORK AT COLD SPRING HARBOR, LONG ISLAND, DURING 1883 AND 1884.

By Fred Mather.

I beg leave to submit the following account of the work at the hatchery under my charge:

The new station of the New York fish commission, leased in 1882 and established in 1883, and designed for hatching both salt and fresh-water fishes, is situated on the north side of Long Island, 32 miles east of New York City by railroad. The harbor was formerly a whaling station, and many old buildings connected with that industry still remain there unoccupied. The line between the counties of Suffolk and Queens runs through the center of the harbor, and while the village and post-office is in the former county, the hatcheries are in the latter. There are two points of especial excellence in the site which will at once commend it, and these are the elevation of the springs, one of which is fully 50 feet above the hatcheries, and the proximity to salt water, which at half tide is only 200 yards away.

Some time in the year 1882 the place was in charge of Mr. Jonathan Mason, one of the men from the New York station at Caledonia, but for some reason not known to me the work was abandoned, and Mr. Mason returned to Caledonia. I visited the station on December 15, 1882, to see what had been done and to note what would be required. On the lower floor of the old mill a distributing trough and six hatching troughs, with thirty-six wire trays, were found. The troughs were 15 feet long and 14 inches wide and were well made, but water had been left standing in them since Mr. Mason left the station, and ice had burst them. A carpenter was ordered to repair them and to make eleven more, and also wire-cloth and other fittings were bought. On January 1, 1883, I came to the station to begin work. I raised the water in the spring reservoir 1 foot and brought it on the second floor of the old mill, and brought nine old hatching troughs from Roslyn, Queens County, where I had hatched salmon for the U. S. Fish Commission the winter before. These old troughs had been hurriedly made of poor lumber, and were placed out-doors in two lines, and received the water from the lower floor, practically making a three-story hatchery. The next year I lowered the water in the reservoir to its former level and used it only on the lower floor; also I brought down,

from the hill above, a spring into another building near by, and fitted it for hatching. This water passes into the upper story of the older hatchery, and, after being used there, flows into the ponds.

The work at the station was begun on January 1, 1883, by the joint operations of the United States and the New York fishery commissioners, and has been continued by both commissions since. The grounds were given, rent free, by Mr. John D. Jones and his brothers, Townsend, Samuel, and Edward, and the upper spring by Dr. O. L. Jones, and in addition to this, Mr. Townsend Jones has given stone from the Connecticut quarries to build a sea-wall to hold the tide at all times. Two old buildings have been fitted up as hatcheries, and the work done in the short space of time will bear close inspection and comparison with older establishments.

In the freshwater department the present capacity of the house has been nearly taxed by the hatching of 500,000 salmon, 10,000 land locked salmon, 38,000 rainbow trout, 50,000 European trout, and 1,000,000 whitefish. The fact that the European trout were in five different lots, which will be enumerated further on, rendered it necessary to place them in separate troughs, even though as small a lot as 2,000, taken from one English stream, were kept separate in a trough which could just as well have accommodated 30,000. The whitefish table will hatch 4,000,000 as well as 1,000,000, so that at present we can say that the capacity of the hatcheries is 800,000 salmon and 4,000,000 whitefish. This can be increased, if necessary.

DIVISION OF EXPENSES OF THE WORK TO JUNE 1, 1883.

From January 1 to June 1 the U. S. Fish Commission paid my salary, and that of my assistants for April and May. During the winter I employed one man at $1.50 per day, and two girls at 50 cents. The girls were very handy at picking out eggs, but the place was too cold and the snows too deep for them to work out-doors. The U. S. Fish Commission also paid the transportation on the fry of salmon and land-locked salmon to the Adirondacks and to Salmon River, Oswego County, and sent a hatching-table and sixteen McDonald hatching jars, completely rigged with glass and rubber tubes and a supply pipe with the peculiar brass cocks used with these jars. During the season of 1883–'84 the division of expense was much the same, the State of New York paying for improvements on the grounds in making ponds, grading, &c., and in building a large salt-water pond where the tide is held by a floodgate at low water and from which it is pumped into a reservoir on the hill and then led into the hatchery in iron pipes, some of which are galvanized and others are covered with coal-tar.

BROOK TROUT (SALVELINUS FONTINALIS).

Our native brook trout were formerly abundant in the ponds on this place, but owing to a lack of protection they were very scarce when the

land was leased to the Fish Commission, about fifty fish being the extent of their number. In 1883 150,000 eggs of the brook trout were presented by the U. S. Fish Commission from the ponds at Northville, Mich., in charge of Mr. Frank N. Clark. The eggs were good, and according to our records the loss in the egg was 9,000, and of fry 19,000, leaving 122,000 when ready for planting. The next year we received 6,000 eggs of this fish from the United States and the fry was planted in ponds near Locust Valley, Long Island, and at Cold Spring Harbor.

RAINBOW TROUT (SALMO IRIDEUS).

Of the rainbow, or California trout, we had two lots of eggs direct from the breeding-ponds of the U. S. Fish Commission on the McCloud River, California, one lot from the hatchery at Northville, Mich., and one from the New York station at Caledonia. None of the eggs were in first-class order and the embryos in many instances burst the shell only to die. The first lot of 30,000 from California either failed to hatch or died shortly after hatching, the majority dying in the egg. The second lot, of 15,000, from the same place, did better and yielded 12,000 fry. The third lot, 30,000, from Caledonia, produced very weak fish of which numbers died about the time of taking food, most of them refusing it altogether. Out of these three lots, aggregating 75,000, we obtained only 26,200 fish. Of 1,000 kept in one of our rearing-ponds there were perhaps 300 fish on January 1, 1884, from 4 to 6 inches in length, showing a remarkable growth. The house being full, the eggs were hatched in the troughs outside where none of the eggs did well. There being no fence about the place the public had access to the troughs at times when the attendants were absent, and the sun was often let into them with injurious effect. During the summer of 1884 these fish did not grow well, although bountifully fed, and they died freely, so that at the close of the season when they were transferred to the larger ponds there was only 68 out of the 300 left. This is a fish that I have never fancied much; and I am in greater doubts as to their value since reading the last report of the New York fish commission, which says:

"A good deal is to be learned yet respecting temperature and other local conditions affecting fish. Till the past year not enough has been done in stocking with rainbow trout to warrant a judgment of their ultimate success in the waters on the Atlantic side. Their time of spawning occurring at a different season from that of the native brook trout, it would not seem to be policy to plant them in waters inhabited by that fish. The protective seasons would need to be different, and inhabiting the same waters one kind might be taken often when the other was fished for, and thus unintended violations would be liable to occur. An obstacle to their ready success in our waters presents itself in the circumstance that at the season the fry are ready to plant, all other fish

are greedily feeding, and consequently a considerable share of the fry would be consumed for food. This, however, may be avoided by providing places where the fry can be free from the presence of predatory enemies till they are able to look after their own safety.

"From the circumstance that they have not always been readily found in the second year, where the plants have been made, it has been surmised that they are a migratory fish—working their own way, as soon as they attain any considerable growth, down-stream toward the ocean. Their disappearance, however, may be accounted for by the other cause stated. Further experiments will be necessary to solve all the problems connected with their establishment in the eastern waters; but the promise continues to be that they will prove themselves a fish of great value in stocking large streams whose temperature is too high for brook trout."

An editorial note in Forest and Stream of May 1, 1884, written by myself, says of the rainbow trout:

"We would call attention to the paragraph in our notice of the report of the New York fish commission concerning these fish. It is beginning to be learned that they are migratory, and do not remain in brooks. We have never been much in favor of this fish, because we have known, what is not popularly known, that the fish is strongly suspected to be a salmon. There is no difference that an ichthyologist can find between the *Salmo irideus* and the salmon known as 'steelhead,' 'hardhead,' and 'salmon trout' on the Pacific coast, the *Salmo gairdneri.* Although this is the case, and the species *irideus* is a doubtful one, yet it has been thought best not to combine them for the present. We have been waiting and watching the habits of this alleged trout with great interest in order to learn if its habits might not show it to be in some respect different from the steelhead. The evidence of the commission tends to show that it is a migratory fish, and if so it may escape to sea and be lost, as the other California salmon were. We believe that Mr. Roosevelt has not seen the rainbow trout which he planted in streams emptying into Great South Bay, Long Island, since they were yearlings."*

If this fish has to be confined by screens to prevent its migrating and perhaps entirely disappearing, as the quinnat salmon did, then it will be useless in our open brooks. The promise of the rainbow trout was that in it we had a quick-growing fish, which was not as sensitive to warm water as our own *fontinalis*, a desideratum which now promises to be filled by the brook trout of Europe, *Salmo fario.*

*At the meeting of the American Fish-cultural Association in Washington, in May, 1884, this assertion that *S. irideus* was identical with *S. gairdneri*, which I regarded as rash for one of my limited ichthyological knowledge, was sustained by no less an authority than Dr. Tarleton H. Bean, who thought, however, that it was best to retain the distinction for a while. The only point that I know of which is against the indentity of these fishes is the alleged fact that *irideus* remains in the streams of the Pacific slope all the year, after reaching the breeding size.

BROWN TROUT (SALMO FARIO).

Early in 1883 the eggs of this species were sent to me as a personal present by Herr von Behr, president of the *Deutsche Fischerei-Verein*, one of the most earnest and enthusiastic fish-culturists in the world. Two varieties were sent, one from the deep waters where they grow large, as in our Maine lakes, and the other from the swift mountain streams of the Upper Rhine, where they are smaller. In 1884 he repeated his gift by sending some to the U. S. Fish Commission, in my care, and some to Mr. E. G. Blackford, commissioner for New York. In 1883, when the fish were sent to me personally, I gave some of them to Mr. F. N. Clark, superintendent of the United States station at Northville, Mich., and to Mr. M. A. Green, of the New York station at Caledonia. Both report them as doing well. In 1884 a lot of 10,000 was presented to the New York fishery commission by Mr. R. B. Marston, editor of the London Fishing Gazette. Of the eggs from Germany the first year the large variety did not hatch as well as the small kind, most of them hatching head first, and both died freely before taking food. The second year they did better and many were distributed to New York waters. The English fish did better at first, but many died during the first three months. At the meeting of the American Fish-cultural Association, in May, 1884, I exhibited some of the large German trout which died in October, 1883, when about six months old, and they were fully six inches long and plump.

These specimens jumped out of the wooden rearing ponds, whose vertical walls project over a foot above the surface of the water. This fish seems to be given to this form of suicide, and it was only when their numbers had been severely thinned by it that we learned that they seemed prompted to it every time they were disturbed, either by putting in a net to catch specimens to show to visitors or at night by some animal swimming in the pond. In November, 1884, when they were a year and a half old, we removed them to a large breeding pond, and the next morning the ground was covered with them, although this pond had banks a foot higher than the rearing ponds. At present not over fifty are left, and learning their habits has been expensive. I had no intimation of this habit from any of my European correspondents, and the fish differs in this respect from our own trout, which readily accepts capture and transfer.

This European brook trout has a larger scale than ours, and to my eye is a more beautiful fish than our own trout. It is a fish that from its habit in Europe should live in the Hudson from North Creek, or above, down to Troy. In Europe it is abundant in the south of England, while the chars, of which our so-called trout is one, are only found in the deep, cool lakes of the north. I believe that we have the necessary conditions on the Atlantic coast to acclimatize successfully this fish. Herr von Behr has promised to send another shipment of eggs,

and in future we will guard against the suicidal instinct, of which we have learned at so much cost.

WHITEFISH (COREGONUS CLUPEIFORMIS).

One million whitefish eggs, from Northville, Mich., were presented by the U. S. Fish Commission in 1883, and were hatched with a loss of only 4 per cent, or 40,000 eggs. Some of the eggs were further advanced than others, and the fry of these (360,000) died before it was decided where to plant them. Six hundred thousand were planted on Long Island, near River Head, in Great Pond, a deep, cold lake, which appears to present the requisite conditions for their support. In 1884 the same number was received, and 400,000 planted in Great Pond, 375,000 in Lake Ronkonkoma, in the middle of Long Island, and 75,000 in "Saint John's Lake," a mill pond at Cold Spring Harbor.

The great surface exposure of the reservoir at this station is favorable to the late hatching of the whitefish. The temperature of the water in the hatchery for the month beginning February 23 and ending March 23 varied from 34° to 48°, the mean being 38½°. Shipments of whitefish were made in 1884 to Great Pond on February 15 and to Lake Ronkonkoma on March 19. This is as late as the fish are hatched in the cold lakes, and the young will find food when planted in March.

SHAD (CLUPEA SAPIDISSIMA).

On May 20, 1884, I received 80,000 shad eggs from Washington, in compliance with my request to be allowed to experiment with them in spring water. They were placed in the McDonald jars, and on May 29 there were planted in the Nissequague River, at Smithtown, Long Island, 78,000 fry. This seems to have been the first trial of hatching this fish in spring water, and as Col. M. McDonald wrote me that the success privately reported might revolutionize present methods I will give the details in full.

[May 20, received 80,000 eggs at 6.20 p. m., put them in the jars at 7.30 p. m. Temperature of water 58° Fahr., of eggs 55°. Eggs began hatching May 24, finished May 27.]

Date.	Temperature of water.	Loss of eggs.	Loss of fry.
May 21	60	30	....
22	59	45	....
23	60	60	....
24	71	40	125
25	62	25	20
26	60	20	42
27	58	15	800
28	59	....	150
29	60	....	40
		235	
Dead on unpacking	....	380	....
		615	1,177
Total loss	....	1,792	

A similar trial made later proved a failure.

From the above table of losses and the round figures given as planted it will be seen that there is a discrepancy of only 208 fish, and these are on my side. Further, my estimate of the eggs received exceeds that of Colonel McDonald by about 5,000. The cool spring water, say, of about 60° (the mean of the above table is 60°.7), seems to account for the absence of fungus on the dead eggs. Having hatched shad eggs in iced water (see Report U. S. Fish Commissioner for 1873–'74, and 1874–'75, pp. 372, 376), and on the rivers of the Atlantic coast from the Pamunkey to the Connecticut, where it has often reached 80°, I find spring water at about 60° to be the best medium for shad eggs which I have used. In the summer of 1884 I made an examination of the shad fisheries of the Hudson for the New York fish commission to find the best place to take eggs. There are several points on the river where eggs can be obtained, and these lie between Kingston and Hudson. The catch of fish during the season of 1884 was a very fair one, owing, no doubt, to the plantings by the State and by the U. S. Fish Commission.

SALMON (SALMO SALAR).

During the spring of 1883 295,000 salmon were distributed to the headwaters of the Hudson and Salmon Rivers, in the State of New York, being the fry from 350,000 eggs of the Penobscot salmon received from the United States salmon works at Orland, Me.

In 1884 there were planted in the same waters 448,700 fry from 500,000 eggs received from Orland. Tables giving the particulars of the distributions will be found at the close of this report. The Salmon River referred to is the one emptying into Lake Ontario near Pulaski, Oswego County, New York, and not the Salmon River of Franklin County, New York, which flows north into the Saint Lawrence River.

LANDLOCKED SALMON (S. SALAR, *var.* SEBAGO).

In 1883 100,000 eggs of this splendid lake salmon were received from the U. S. Fish Commission from the breeding establishment in Maine, in charge of Mr. Charles G. Atkins, Professor Baird reserving 10,000 of the fry to be distributed as he might direct, and the remainder to be at the disposal of the New York commission. Eighty-five thousand fry were distributed, as per table.

In 1884 there were received 41,500 eggs of this fish, most of which were sent to the Bisby Club, at Bisby Lake, Herkimer County, New York, at the request of General R. U. Sherman, of the board of New York fish commissioners.

POPULARITY OF THE STATION.

The station has become very popular among people in this portion of the State, a most substantial proof of which is the fact that after its establishment by the State fishery commission it was feared that it would

have to be closed for lack of funds, and several gentlemen offered to contribute to its support until such time as the State might furnish the funds to carry it on. Upon presenting this matter to the consideration of Mr. E. G. Blackford, of the Board of Fish Commissioners, it was decided not to call upon private aid unless it became absolutely necessary, which fortunately it did not. In addition to the use of land and buildings given by Mr. John D. Jones and his brothers, Townsend, Samuel, and W. E. Jones, Mr. Townsend Jones has given the stone for the great wall of the salt-water pond. This stone is brought from the brownstone quarries of Connecticut, and is in large blocks, making a solid wall. Mr. Jones sent three schooners for this stone, and each brought about 200 tons. The actual cost of this I do not know, but it cannot be far from $1,500. Messrs. John D. and Townsend Jones have built a large and handsome house near the hatchery for my use. It has hot and cold water and gas throughout, and has spacious grounds. Dr. O. L. Jones paid $64.80 for drain-pipe to lead the water from his pond on the hill into the brick hatchery, thereby giving us an additional supply of water for both the hatchery and the ponds. Mr. E. R. Wilbur, of Forest and Stream, gave a water telescope, to be used in examining the bottom of ponds.

THE SALT-WATER DEPARTMENT.

This portion of the work has been done entirely by the State, assisted by the Messrs. Jones. On October 10, 1883, the Board of State Commissioners approved the plans for introducing salt water and ordered the work to begin. Mr. Townsend Jones, in addition to promising to give the stone necessary for the sea-wall, also agreed to have the last of it on the ground within sixty days, which was done. It was decided to build this wall so as to inclose two sides of a pond, the beach forming the other two, and by placing a floodgate in it the water would be retained at low tide and it would not only be available for a place to store valuable native or foreign fishes, but would serve as a reservoir from which to pump. I had previously gone over the upper end of the harbor very carefully with a hydrometer and had tested the water in different parts at flood-tide and found that the water was saltest at this point. The scale of the hydrometer is so graduated that when placed in distilled water it stands at 1. At a temperature of 62° Fahrenheit sea-water in mid-ocean raises the scale to 1.028, and at the point where our floodgate is placed the density varies from 1.019 to 1.022, and codfish have been hatched, I am informed, with a density of 1.010. From this pond 800 feet of 5-inch drain-tile bring the water within 150 feet of the hatchery, where it is pumped by a 6-inch cylinder "Rider" hot-air compression engine into a reservoir on the hill, whence pipes bring it to the house. This engine runs with the consumption of only an ordinary scuttleful of coal in ten hours, and it is claimed will pump 1,000 gallons an hour to a height of 50 feet. It runs very satisfactorily, and

we shall need to run it only about six hours per day when we are using the water.

The large pond was found to require banking outside the wall as well as inside, for the seas went through it and cut out the inside embankment. In this place we were fortunate in not striking springs of fresh water, which are common all along the beach, but we found great trouble from this cause, and also from quicksands, in laying the drain-tile. The winter of 1883 closed in early and we were compelled to suspend out-door labor and to defer until spring the completion of the great tidal reservoir, but we were enabled to hold the water as high as half tide and to begin work. The hot-air engine worked very well, and we hatched the eggs of some fish which laid them in clusters on the sea-weed and which the fishermen all erroneously declared to be those of the little tom-cod (*Microgadus tomcodus*), locally known as "frost-fish" in the fall of the year, and as tom-cod in the spring. I sent some of these eggs to Prof. J. A. Ryder, at the central hatching station of the United States Fish Commission, and he hatched them in artificial sea-water. The spawning season of this unknown fish is in November and December, and they had finished spawning before our engine was in position, but we gathered the eggs from the seaweed, to which they are attached in bunches the size of a hen's egg, and are easily obtained by the oystermen when raking for oysters. What the eggs were I will not attempt to guess, but the following year, 1884, we took the eggs of the tom-cod from the fish and found them free and heavy, and the appearance of the embryo differed from the unknown eggs.

In the winter of 1883–'84 we obtained several million codfish eggs from the cars at Fulton Market, but none of them were good. They showed the shrunk vitellus which gives both them and shad eggs a "speckled" appearance, which indicates that there is no possibility of impregnating such eggs. In every case the parent fish had been brought in the well of a fishing smack, and after being dipped out had been thrown into the floating car alongside, falling from 4 to 6 feet, usually on the abdomen. This, in my opinion, is more than the delicate cod egg can stand. The membrane, or shell, covering the egg of the codfish, is so delicate that a light touch of the finger, when the egg is on any hard substance, will burst it like a soap-bubble, while a trout's egg will bear the hardest squeeze that can be given between the finger and thumb. In December, 1884, we obtained one lot of eggs from the same place, which floated and appeared good when taken, but were dead and at the bottom of the jars on arriving at the hatchery. Later the fish came in dead and we have never had good cod eggs in the hatchery. In November, 1884, I visited Wood's Holl and saw the apparatus devised by Capt. H. C. Chester, and on my return made a similar one of zinc instead of wood. I used a big wooden tank 12 feet long by 6 feet wide and 3 feet deep. The hatcher was merely an elliptical piece of zinc, 5 feet 8 inches long by 2 feet wide, without bottom, and

resting on legs which kept it 2 inches off the floor of the tank, the top of the hatcher being above the water-line. In this were inserted three pieces of rubber tubing, so arranged as to give a continuous movement to the water around the tank in one direction, the good eggs to be kept floating and the bad ones sinking. This was a copy of Captain Chester's arrangement, made a trifle deeper, and of zinc. I also obtained a pork barrel and put a brass cock in the bottom, to which was attached a rubber tube, which, by raising or lowering, regulated the height of water in the barrel, or drew it off entirely. A rubber tube from the supply pipe above dropped into the barrel and delivered the water with a slight inclination upward and around it. So far no opportunity has offered to test these hatchers. At present it is proposed to send a smack load of live cod to be kept here in cars until ripe. If this is done early next season, before the harbor freezes, no doubt many good eggs may be obtained. I never saw codfish eggs float until I saw them do so at Wood's Holl, but early in December, 1884, my assistant, Mr. F. A. Walters, obtained eggs at Fulton Market which floated in water taken from Cold Spring Harbor. These are referred to above. At the meeting of the American Fish-Cultural Association, in Washington, in May, 1884, in reply to a question from Mr. E. G. Blackford, Prof. John A. Ryder said:

"My experience with codfish eggs, both at Fulton Market and at Wood's Holl, has been quite extensive. Our greatest success in handling these eggs has been in comparatively salt water, as Colonel McDonald can testify. The eggs taken at Wood's Holl were from fish that had been kept under the same conditions as those in Fulton Market. At the former place the eggs would float as they should normally, but at Fulton Market they had no tendency to float as did the eggs from the more northern locality. I also observed that in most cases the eggs had an abnormal appearance. The vitellus was disorganized, and the vitelline matter and germinal material were pulled out of shape. The germinal disk was formed, but defectively; in many instances, after formation, it had been broken into irregular fragments, which were certainly not characteristic of normal segmentation. What the cause was I cannot say, but I believe that the confinement of parent female fish of any species would have a tendency to interfere with the fertility of the ova. That has been the experience at Havre de Grace with the shad, and I should not be surprised if the confinement of female cod in the wells of the fishing smacks and in the cars would tend to cause the eggs which were mature and still contained in the ovaries, to become, to a certain extent, disorganized and therefore incapable of fertilization. My conclusions have been formed deliberately, although the data have been very imperfect. There was this important difference between the eggs taken at Wood's Holl and Fulton Market. The latter exhibited a decided tendency to sink, which in our Wood's Holl experiment we always associated with a condition indicating that

such eggs would never hatch. We invariably noticed this to be the case, and concluded to accept it as prima facie evidence that whenever a cod egg went to the bottom, that was the last of it, so far as its capacity for development was concerned."

To this I replied: "I have observed that the codfish eggs which I have taken at Fulton Market, New York, had a tendency to sink, as just stated by Professor Ryder. When I removed them from the pan into a jar, the same thing occurred, and you could see the upper line of the eggs about half way up the jar. When placed in the McDonald hatching jars, they acted like whitefish eggs, except that they were a little lighter. The moment the circulation of the water stopped they all sunk to the bottom. I confess to having been somewhat skeptical about 'floating eggs' of codfish, although I understand from Professor Ryder and Colonel McDonald, that at Gloucester the eggs actually floated on the surface, resembling in appearance a honey-comb, and that they were so buoyant that a portion of the egg would literally stand out of the water. I attributed the failure to impregnate the eggs taken at Fulton Market to the shock which the fish suffers by being thrown into the cars from the fishing smacks. They are cast from the deck to the surface of the water, a distance of from 4 to 6 feet, and usually strike on their bellies. The cod egg is exceedingly delicate, and breaks like a soap-bubble at a touch."

Colonel McDonald then said: "The fish from which the eggs at Wood's Holl were taken, were, as far as I know, handled very carefully, being transferred from the smack to the car with as little violence as possible. But may not the difference in the results of the observations made at Wood's Holl and Fulton Market, be explained by a difference in the density of the water at the two places? Of course the buoyancy of the cod egg depends upon the density of the water in which it is placed. Now at Wood's Holl, where the water opens out to the ocean, it surely must be much more dense than at New York Harbor, and the effect of this difference upon the eggs is clearly proved by the fact that those eggs which floated at Wood's Holl sunk at New York. In regard to the eggs taken at New York, they were sent on in hermetically sealed jars to Washington, where on arrival they were found to be impregnated and a small proportion developing. They were then put into salt water artificially prepared (5 ounces of salt to the gallon of water). Development went on, I think, for fifteen or sixteen days, until the embryo was moving and the heart beating, and yet after all we did not succeed in hatching them. Up to that time their development, I believe, was normal. The embryological investigations were carried on by Professor Ryder, who, perhaps, will add a few words."

Prof. Ryder remarked: "You do not mean to say that all the eggs taken were fertile, but that the greater portion of them were. There were large quantities that I know would come to nothing. The vitel-

lus had turned to a brownish hue, and the germinal disk was disorganized."

When the water is full of fine ice or snow "mush," the codfish in the wells of the smacks die freely and their stomachs are found filled with the chilling material, notwithstanding the fact that they are winter spawners and come to the shores of Long Island in winter, where large numbers are taken at that time. In the summer months, when the Gulf Stream is some 200 miles nearer our coast, no codfish are ever found about the bays or harbors of the island. We now propose to bring a smack load of cod here and confine them until they spawn.

Distribution of Penobscot salmon from Cold Spring Harbor in May, 1883, *on account of the U. S. Fish Commission.*

Date.	Fish supplied.	Loss in transportation.	Fish planted.	Stream.	Tributary of—	Messenger.
May 10	50,000	200	49,800	Carr's Brook	Hudson	F. A. Walters.
May 11	5,000	....	5,000	Of J. D. Jones	Great South Bay	Long Island Railroad Express Company.
May 14	50,000	300	49,700	Balm of Gilead	Hudson	F. A. Walters.
May 17	45,000	800	44,200	Salmon River	Lake Ontario	O. B. Hewitt.
May 22	40,000	1,000	39,000	Raymond	Hudson	O. B. Hewitt.
May 23	40,000	100	39,900	Beaver Meadow.	Hudson	F. A. Walters.
May 24	40,000	500	39,500	Roaring Brook	Hudson	O. B. Hewitt.
May 28	40,000	*12,100	27,900	Roaring Brook	Hudson	O. B. Hewitt.
Total	310,000	15,000	295,000			

*This loss was attributed by Mr. Hewitt partly to a lack of ice and partly to the length of time they had remained in the troughs, which predisposed them to die.

Distribution of Penobscot salmon from Cold Spring Harbor in 1884, *on account of the U. S. Fish Commission.*

Date.	Fish supplied.	Loss in transportation.	Fish planted.	Stream.	Tributary of—	Messenger.
April 30	40,000	1,200	38,800	Roaring Brook	Hudson	F. A. Walters.
May 1	40,000	2,000	38,000	Raymond	Hudson	C. F. Warren.
May 6	40,000	1,000	39,000	Balm of Gilead	Hudson	C. F. Warren.
May 7	40,000	800	39,200	Carr's Brook	Hudson	F. A. Walters.
May 9	40,000	1,000	39,000	Glen	Hudson	C. F. Warren.
May 12	40,000	1,400	38,600	Loon Lake	Hudson	C. F. Warren.
May 14	40,000	2,500	37,500	....	Salmon River	C. F. Warren.
May 19	45,000	4,000	41,000	Clendon	Hudson	C. F. Warren.
May 21	40,000	1,100	38,900	North Creek	Hudson	C. F. Warren.
May 22	5,000	....	5,000	Cold Spring Harbor.	Long Island Sound.	Fred Mather.
May 26	40,000	3,000	37,000	Kelso	Hudson	C. F. Warren.
May 27	38,700	2,500	36,200	Indian River	Hudson	F. A. Walters.
Total	448,700	20,500	428,200			

Distribution of landlocked salmon from Cold Spring Harbor in May and June, 1883.

Date.	No. of fish.	Where planted.	By whose order.	Person in charge.
May 3	3,500	Mill pond, Cold Spring Harbor	E. G. Blackford	Fred Mather.
3	40,000	Lakes of Fulton chain	R. U. Sherman	John Brinckerhoff.
7	5,000	Great pond, Montauk Point	E. G. Blackford	Long Island R. R. Co.'s Express.
16	20,000	10,000 Woodhull Lake; 10,000 Black River, South Lake.	R. U. Sherman	Frank Hall.
25	2,500	Mill pond, Cold Spring Harbor	E. G. Blackford	Fred Mather.
June 11	5,000	Greenwood Lake, Orange County, N. Y.	S. F. Baird	Fred Mather.
13	5,000	South Side Club, of Long Island	S. F. Baird	F. A. Walters.
13	4,000	Ponds near Sayville, Suffolk County	R. B. Roosevelt	F. A. Walters.
Total	85,000			

Distribution of landlocked salmon from Cold Spring Harbor in 1884.

	Number.
Eggs sent to the Bisby Club, Oneida County, N. Y.	31,000
Eggs hatched at Cold Spring Harbor, N. Y.	10,500
	41,500
Fry deposited in ponds of Townsend Jones, and of hatchery	8,500

Distribution of whitefish from Cold Spring Harbor, March, 1883.

Date.	No. of fish.	Where planted.	Messenger.
Mar. 20	40,000	Mill Pond, Cold Spring Harbor *	Fred Mather.
24	560,000	Great Pond, near Riverhead, Long Island †	F. A. Walters.

* This pond is only 16 feet deep, and I have no confidence in their living here. Our kind landlord wished to try the experiment.
† Great Pond is 70 feet deep in places, and the fish may thrive.

Distribution of whitefish from Cold Spring Harbor, 1884.

Date.	No. of fish.	Where planted.	Messenger.
Feb. 15	400,000	Great Pond, Long Island	F. A. Walters.
Mar. 6	75,000	Saint John's Lake, Long Island	Fred Mather.
19	375,000	Lake Ronkonkoma, Long Island	F. A. Walters.

Distribution of shad from Cold Spring Harbor, 1884.

Date.	No. of fish.	Where planted.	Person in charge.
May 29	72,000	Nissequague River	Walter S. Stoots.

Distribution of brook trout from Cold Spring Harbor in April and May, 1883.

Date.	No. of fish.	Delivered to—	Post office address.	For what streams.	On account of—
Apr. 25	5,000	J. F. Sutton	Bedford Station, Harlem Railroad.		N. Y. Fish Com.
May 3	5,000	Townsend Jones	Cold Spring Harbor	Mill Pond Brook	U. S. Fish Com.
4	10,000	John Cashow	Locust Valley	Shoe Swamp Brook	N. Y. Fish Com.
8	5,000	W. H. O'Donnel	Daily News, 25 Park Row, New York.	Brooks, near Peekskill.	N. Y. Fish Com.
9	10,000	R. S. McCracken	Hackettstown, N. J.	Musconetcong, N. J.	U. S. Fish Com.
11	10,000	W. Holberton	Hackensack, N. J.	Cedar Creek and Newbridge Creek, near Merricks, L. I.	N. Y. Fish Com.
11	5,000	John D. Jones	91 Wall street, New York.	South side of Long Island.	U. S. Fish Com.
17	8,000	N. W. Foster	Riverhead, N. Y.	Near Riverhead, L. I.	N. Y. Fish Com.
25	3,000	Townsend Jones	Cold Spring Harbor.	Mill Pond Brook	U. S. Fish Com.
	1,000	Kept at hatchery.			
Total	62,000				

Distribution of brook trout from Cold Spring Harbor in 1884.

[Eggs received, 6,000.]

Date.	No of fish.	Delivered to—	Post-office address.	For what streams.	On account of—
April 20	1,000	John Cashow	Locust Valley, N. Y	Shoe Swamp Brook	N. Y. Fish Com.
23	4,000	Townsend Jones	Cold Spring Harbor.	Saint John's Lake	U. S. Fish Com.

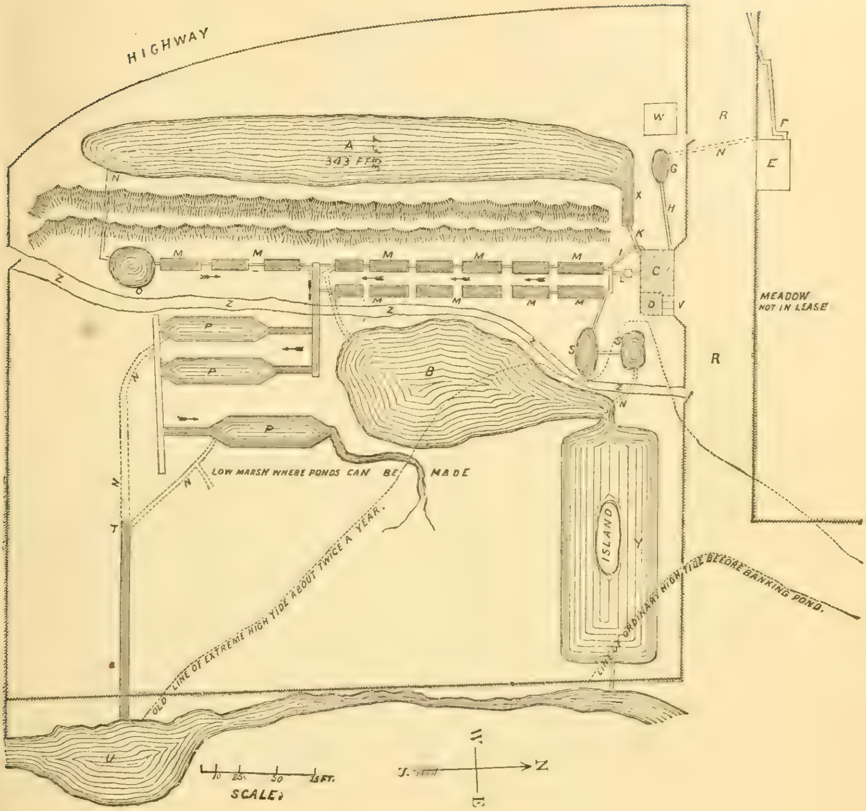
Distribution of rainbow trout from Cold Spring Harbor, July, 1883.

Date.	No. of fish.	Delivered to—	Post-office address.	For what streams.	On account of—
July 4	1,200	F. S. Weeks	Cold Spring Harbor	Below beach	N. Y. Fish Com.
	2,000	J. Reynal	84 White street, N. Y	Westchester Co	N. Y. Fish Com.
	5,000	South Side Club	Oakdale, Suffolk Co	On grounds	U. S. Fish Com.
	5,000	S. L. M. Barlow	1 Madison ave., N. Y.	Near Montauk	N. Y. Fish Com.
	1,000	Kept at hatchery			
	*12,000				
	26,200				

* Escaped from troughs into harbor.

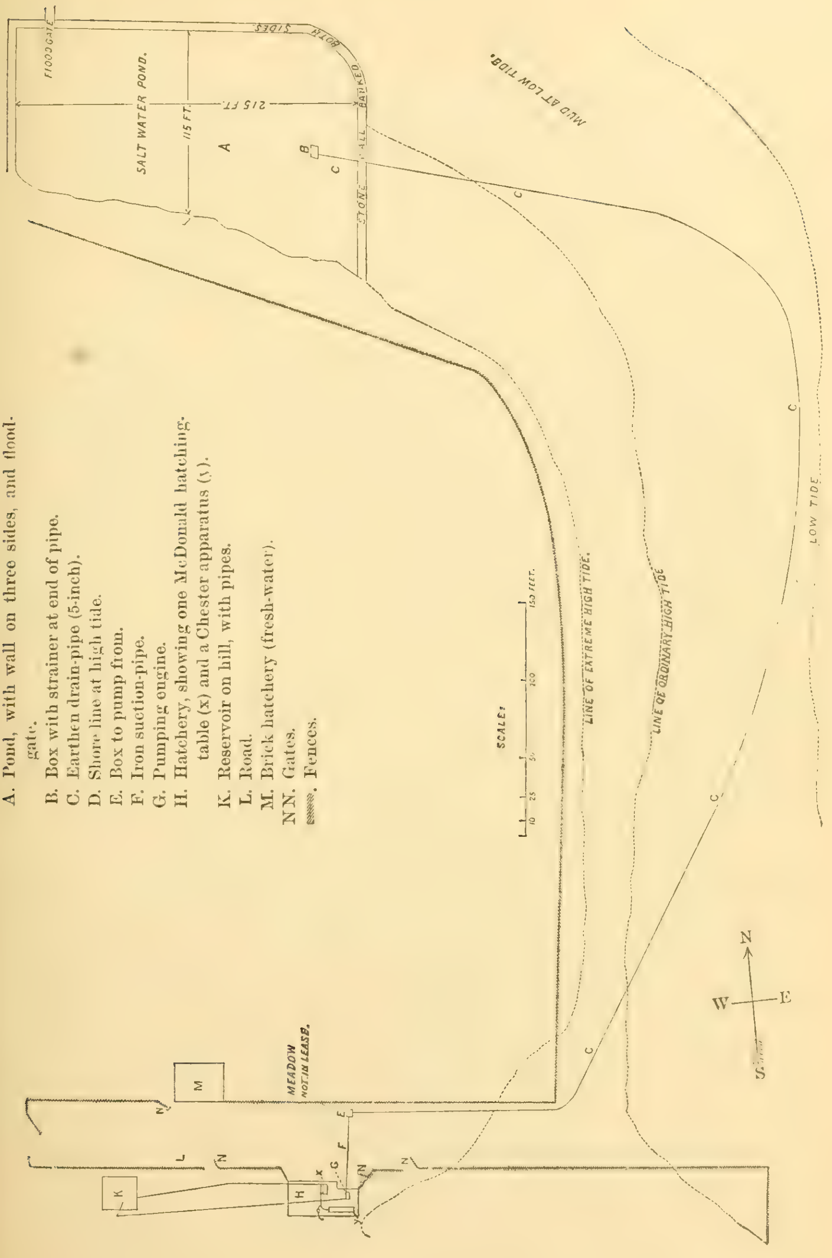
Distribution of rainbow trout from Cold Spring Harbor in 1884.

Date.	No. of fish.	Delivered to—	Post-office address.	For streams.	On account of—
April 23	6,000	Townsend Jones	Cold Spring Harbor.	Mill ponds	U. S. Fish Com.
May 15	4,000	F. S. Weeks	do	Below beach	U. S. Fish Com.



A. Spring reservoir.
B. An old pond on low ground.
C. Two-story hatchery (old mill).
D. Salt-water hatchery and engine-house.
E. Brick hatchery on hill.
F. Filter, with pipe from a spring not shown.
G. Settling reservoir receiving water from E.
H. Supply-pipe to 2d story of old hatchery.
I. Waste-pipe from 2d story of old hatchery.
K. Supply-pipe to lower floor.
L. Waste-pipe from lower floor.
MM. Rearing-ponds, 25 by 6 feet, of boards.
NN. Underground drains.
O. Pond in earth supplied from A.
PP. Ponds for older fish.
R. Highway, unused at present.
SS. Ponds in earth.
T. Outlet ditch.
U. Outlet of mill-ponds above, not connected with grounds.
V. Coal and wood bins.
W. Salt-water reservoir.
X. Flume belonging to old mill, C.
Y. Pond, made with sod-wall and island.
Z. Wagon-road.
Fences.

MAP OF FRESH-WATER DEPARTMENT.



A. Pond, with wall on three sides, and flood-gate.
B. Box with strainer at end of pipe.
C. Earthen drain-pipe (5-inch).
D. Shore line at high tide.
E. Box to pump from.
F. Iron suction-pipe.
G. Pumping engine.
H. Hatchery, showing one McDonald hatching-table (x) and a Chester apparatus (y).
K. Reservoir on hill, with pipes.
L. Road.
M. Brick hatchery (fresh-water).
N N. Gates.
▬. Fences.

MAP OF SALT-WATER DEPARTMENT.

V.—EGGS RECEIVED FROM FOREIGN COUNTRIES AT COLD SPRING HARBOR, NEW YORK, AND RETAINED OR FORWARDED DURING THE SEASONS OF 1883-'84 AND 1884-'85.

By Fred Mather.

A. Brown trout (*Salmo fario*).—February 28, 1883, I received two lots of eggs of the European brook trout, which, to distinguish from our native fish, I have called by the English name of "brown trout," as more likely to strike the popular fancy in this country than the German name of "bachforelle." The eggs were consigned to me personally by Herr von Behr, president of the *Deutsche Fischerei-Verein*, and consisted of 60,000 of a large kind, and 20,000 from streams tributary to the Upper Rhine, which were smaller, but were of the same species. The eggs were very far advanced when received, many having hatched in the packages, and a great number of the eggs were indented, an injury caused by lack of moisture. An announcement of the arrival of these eggs in Forest and Stream brought applications for them, and on March 10, I sent 10,000 of the large and 2,000 of the small kind to the New York Station at Caledonia. On March 21 I sent to the U. S. Fish Commission at Northville, Mich., 2,000 of the large and 3,000 of the small kind. In the hatchery under my charge at Cold Spring Harbor, the large eggs hatched head first, and I never knew any of the salmon family to live if they broke the shell in that manner. The large fish all died in from three to seven days after hatching. The smaller kind did better, and some 4,000 were placed in a rearing pond 25 feet long, 6 feet wide, and 3 feet deep, with vertical sides of boards, which extended 1 foot above the water. When six months old the pond contained several hundred fine fish fully 6 inches in length, as plump, well-fed trout as ever delighted the eye of a fish-culturist. We were so proud of these fish that we often caught them to show visitors, and as often as we disturbed them we would find many dead ones on the ground the next day. It was not until our stock was nearly exhausted that we noted the connection between the disturbance and the deaths, and removed the fish to safer quarters. The tendency to suicide in this fish seems unknown in Germany, and has not been manifested here since the transfer to a larger and deeper pond. I have (September, 1885) perhaps forty of these fish two and a half years old, which are as beautiful trout as I ever saw, and from which spawn is expected in a few months. The

breed will be kept pure, for I am not in favor of hybridizing a fish that is good enough, or, in fact, any fish unless it is merely in the way of scientific experiment.

On February 15, 1884, we received a box of brown-trout eggs from Herr von Behr, containing 16,000 of the large kind, half of which were consigned to Mr. E. G. Blackford, New York City, and the remainder to me; and 54,000 of the small kind, 32,000 of which were for me, and 22,000 for Mr. Blackford. Of the large variety I sent 3,000 to the New York station at Caledonia, 1,000 to the United States station at Northville, Mich., and 2,000 to Central Station at Washington, D. C. Of the small variety we sent 10,000 to Caledonia, 4,000 to Northville, and 9,000 to Central Station at Washington. The distribution of fry from Cold Spring Harbor will be found in the following tables.

On February 25, 1884, there were received as a present to the American Fish-Cultural Association from the Fishing Gazette of London, by its editor, R. B. Marston, esq., three lots of brown trout; 5,000 from Mr. Andrews's "best fish;" 3,000 from the Itchen; and 2,000 from the Wey; all from the hatchery of Mr. Andrews, at Guilford, Surrey. These eggs arrived in good condition, and were hatched and distributed. Those we retained cannot be distinguished from the same species from Germany. The White Star Line of steamers brought them from England free of charge. The letters below relate to the eggs from Germany:

"A box of European trout eggs (*Salmo fario*) arrived last night, and was forwarded this morning to Wytheville by Mr. Moore, who goes there to make the distribution of California trout; and we hope to be able to give a good account of them. We will retain enough for breeders, and make a single plant of the rest in some suitable stream in the vicinity of the hatchery." [M. McDonald, chief of division of distribution, Washington, D. C., February 23, 1884.]

"The German trout eggs arrived February 18 in prime order. Very few dead. They hatched about a week ago." [Frank N. Clark, Northville, Mich., March 24, 1884.]

On February 24, 1885, there was received from Herr von Behr, president of the *Deutsche Fischerei-Verein*, a case of 40,000 eggs of brown trout; half of them were consigned to Mr. E. G. Blackford, and half to myself. The eggs were in fair condition, 1,020 being dead on unpacking, and 2,594 were lost before hatching. Of the fry, 8,131 died before distribution, leaving 28,000 fry, of which nearly 19,000 were distributed. See table.

B. SAIBLING (*Salmo salvelinus*).—On January 10, 1881, Mr. Carl Schuster, burgomaster of Freiburg, Germany, announced that he had sent 60,000 saibling eggs by the North German Lloyds steamer Mosel, of January 8, consigned to the U. S. Fish Commission. These reached New York on January 22. They were forwarded the next day to Mr. A. H. Powers, Plymouth, N. H., which point they reached on the 24th. The entire loss while crossing the ocean and being transported to the

hatchery was but 5,000 eggs. Mr. Powers was directed to hatch them and place them in Newfound Lake, located 7 miles from Plymouth. The eggs were all hatched by February 28, with a loss in hatching of 6,515 eggs. Mr. Powers deposited 30,000 fry in Newfound Lake on May 18.

Another instalment of saibling eggs was announced by Max von dem Borne on February 3. These were lost in transit.

C. GERMAN WHITEFISH (*Coregonus*).—Received on January 30, 1885, one box, containing 50,000 eggs of the small species of Coregonus (*Madue maræna*) inhabiting Lake Constance, sent by Herr von Behr from the hatchery of Carl Schuster, Freiburg, in Baden. The eggs were in good condition, and by order of Professor Baird were repacked and shipped to Mr. Charles G. Atkins, Bucksport, Me.

D. LOCH LEVEN TROUT (*Salmo levenensis*).—On January 2, 1885, we received from Sir James G. Maitland, Howietoun Fishery, Stirling, Scotland, six cases, containing 100,000 eggs of the Loch Leven trout. They were in remarkably good condition, in fact the best I ever received from across the water, as very few were indented and only 870 were dead; 80,000 were sent to Mr. F. N. Clark, Northville, Mich.; and 10,000 to the Bisby Club, Herkimer County, New York, of which General R. U. Sherman, of the New York fish commission, is president. General Sherman reports the eggs as doing well, and the trout as fine as he ever saw. From what I can learn of this fish, it seems to be a very desirable one to introduce into our waters.

Distribution of brown trout (Salmo fario), eggs and fry, from Cold Spring Harbor, New York, in 1883.

Date.	Number of eggs.	Number of fry.	Destination.	At request of—
Mar. 10	12,000	....	Caledonia, N. Y	S. Green, superintendent.
22	5,000	....	Washington, D. C.*	Prof. S. F. Baird.
Total..	17,000	....		

* These eggs were sent from Washington to Wytheville, Va.

Distribution of brown trout (Salmo fario), eggs and fry, from Cold Spring Harbor, New York, in 1884.

Date.	Number of eggs.	Number of fry.	Shipped to—	By order of—
Feb. 16	13,000	....	M. A. Green, Mumford, N. Y	E. G. Blackford.
16	5,000	....	F. N. Clark, Northville, Mich	Prof. S. F. Baird.
21	11,000	....	Col. M. McDonald, Wytheville, Va	Do.
Apr. 23	....	6,000	Jones & Hewlett, Cold Spring Harbor, N. Y	Fred Mather.
May 1	....	3,000	A. N. Frye, Bellmore, Long Island, N. Y	E. G. Blackford.
5	....	3,000	Charles J. Stewart, Jamaica, Long Island, N. Y	Fred Mather.
20	....	3,000	J. J. O'Connor, 62 Wall street, New York City	Do.
21	....	8,000	Townsend Jones, Cold Spring Harbor, N. Y	Do.
22	....	2,000	New York fish commission, Cold Spring Harbor, New York.	Do.
22	....	12,000	R. B. Roosevelt, Sayville, N. Y	R. B. Roosevelt.
22	....	3,000	H. B. Hyde	E. G. Blackford.
Total..	29,000	40,000		

Distribution of brown trout (Salmo fario), eggs and fry, from Cold Spring Harbor, New York, in 1885.

Date.	Number of fry.	Shipped to—	Name of stream.	By order of—
April 30	2,000	H. S. Jennings, Islip, N. Y	Not known	E. G. Blackford.
May 3	5,000	George Snyder, Manhasset, N. Y	Private ponds.	Do.
4	1,000	J. R. Wood, Cold Spring Harbor, N. Y	do	Fred Mather.
12	1,000	F. H. Weeks, Cold Spring Harbor, N. Y	Swamp Brook.	Do.
13	700	H. Scudder, Northport, N. Y	Not known	E. G. Blackford.
15	2,500	Dr. A. K. Fisher, Sing Sing, N. Y	do	Do.
21	2,000	A. W. Humphries, Sterlington, N. Y	Sterling Lake.	Do.
30	1,200	Weeks & De Forest, Cold Spring Harbor, New York.	Oyster Bay	Do.
30	3,500	Townsend Jones, Cold Spring Harbor, N. Y.	Private ponds.	Do.
Total	18,900			

VI.—ACCOUNT OF EGGS REPACKED AT COLD SPRING HARBOR, N. Y., AND SHIPPED TO FOREIGN COUNTRIES, UNDER THE DIRECTION OF THE U. S. FISH COMMISSION, DURING THE WINTER OF 1884-'85.

By FRED MATHER.

GERMANY.

A. WHITEFISH (*Coregonus clupeiformis*).—On January 8 received from Mr. Frank N. Clark, superintendent of the hatching station at Northville, Mich., 1,000,000 eggs of whitefish in good order. They were repacked and shipped to Herr von Behr, president of the *Deutsche Fischerei-Verein*, Berlin, care of Mr. Busse, Geestemünde, by the steamer Salier, of the North German Lloyds, on January 10. They arrived at Geestemünde in good order, but by some misunderstanding half of them were shipped from there to Switzerland.

On February 20 another lot of 1,000,000 eggs were received from Mr. Clark, and were repacked and shipped to the same address as above, on February 25, by steamer Eider. These and eggs of other fish did not receive proper attention on the ship, and arrived with no ice in the boxes and in very bad condition.

B. LANDLOCKED SALMON (*S. salar* var. *sebago*).—March 27 received from Mr. Charles G. Atkins, in charge of the United States station at Grand Lake Stream, Maine, 40,000 eggs, and repacked and shipped to the *Deutsche Fischerei-Verein*, Berlin, care of F. Busse, Geestemünde, by steamer Eider. As stated in the case of the whitefish, above, there was a lack of ice in the boxes, and a card from Herr von Behr of April 11 says that they were "nearly" all lost. As a rule the eggs have been well attended to on this line.

C. RAINBOW TROUT (*Salmo irideus*).—March 30 received from Mr. Clark 10,000 eggs, and repacked and shipped as above by steamer Eider. These eggs were all lost for want of ice on the voyage. It will be seen that of the three lots sent by this ship very few arrived safely. The following translation explains their condition:

"GEESTEMÜNDE, *April* 12, 1885.

"MR. VON BEHR, SCHMOLDOW.

"SIR: Unfortunately the last consignment of fish-eggs again arrived here without any ice whatever; even the sides of the box were dry, and

the result, of course, was very serious. The *irideus* had decayed already to such a degree that not *a single* egg could be distinguished on the frames. The *landlocked* had already developed very considerably, and some of the young fish had slipped out of the eggs.

"I have this day sent 2,000 to each of the persons for whom they were destined, and 9,000 to Starnberg. A detailed report will follow to-morrow, because to-day I am too busy picking out the eggs.

"Very respectfully,

"F. BUSSE."

D. BROOK TROUT (*Salvelinus fontinalis*).—February 7 received 40,000 eggs from Mr. Clark, and shipped to the *Deutsche Fischerei-Verein* February 11, by steamer Fulda. These eggs were better cared for on the voyage and arrived in good order. All the eggs to Germany were carried free of charge by the North German Lloyd Steamship Company.

ENGLAND.

A. WHITEFISH (*Coregonus clupeiformis*).—January 8 received from Mr. Clark, Northville, Mich., 250,000 eggs, and repacked and shipped them to the National Fish Culture Association, South Kensington, London, care of Mr. Edward Birbeck, on January 14, by steamer Gallia. They arrived in good order, as will be seen by a letter from Mr. Chambers, secretary of the association, appended to the account of the following shipment.

B. LAKE TROUT (*Salvelinus namaycush*).—January 8 received from Mr. Clark 30,000 eggs, and repacked and shipped by steamer Gallia on January 14. The following extract from a letter shows their condition on arrival:

"[National Fish Culture Association, Exhibition Grounds, South Kensington.]

"LONDON, *February* 10, 1885.

"MY DEAR SIR: The consignment of 250,000 whitefish ova and 30,000 lake trout ova duly arrived at Liverpool, where they were met by our agent and dispatched to our hatchery at South Kensington. I have great pleasure in stating that upon opening the boxes, the various eggs were found to be in excellent condition and the rate of mortality remarkably low. I have delayed writing to you in order to send a later report as to their condition, which at the present time is all that can be desired. Please accept my hearty congratulations upon the efficacious mode adopted in packing the eggs, which has proved a signal success. I have written to Professor Baird upon the subject.

"Faithfully yours,

"W. OLDHAM CHAMBERS.

"FRED MATHER, Esq.,

"*Cold Spring Harbor, N. Y.*"

C. SALMON (*Salmo salar*).—January 31, received from Mr. Charles G. Atkins, Bucksport, Me., 30,000 eggs of Atlantic or Penobscot salmon. Repacked and shipped to the National Fish Culture Association by steamer Scythia on February 4. The following letters show their condition on arrival:

"LONDON, *February* 25, 1885.

"Mr. FRED MATHER.

"MY DEAR SIR: I have the pleasure to inform you that the Penobscot salmon eggs arrived at South Kensington in grand condition, the death rate being under 1 per cent. The eggs still maintain the excellent condition in which they arrived.

"Yours faithfully,

"W. OLDHAM CHAMBERS,

"*Secretary.*"

[National Fish Culture Association, Exhibition Grounds, South Kensington.]

"LONDON, *February* 25, 1885.

"The Hon. Prof. SPENCER BAIRD,

"*Commissioner of Fish and Fisheries, Washington.*

"MY DEAR SIR: Allow me, on behalf of the council of the National Fish Culture Association, to thank you for the further presentation of Penobscot salmon eggs and about 7,000 *fontinalis* eggs, which arrived here in excellent condition, and were immediately transferred to our hatchery.

"It will, I am sure, be interesting to you to know that all the eggs still maintain the excellent condition in which they arrived.

"I must again compliment you upon the admirable system adopted by you in packing the eggs, which is worthy of great commendation.

"Yours faithfully,

"W. OLDHAM CHAMBERS,

"*Secretary.*"

D. BROOK TROUT (*S. fontinalis*).—February 7, received from Mr. Clark 25,000 eggs, and repacked and shipped them to the National Fish Culture Association February 11, on steamer Servia. As to their arrival, see letter of February 25, above.

E. LANDLOCKED SALMON.—March 27, received 30,000 eggs from Mr. Atkins; repacked and shipped to the National Fish Culture Association April 1, by steamer Bothnia.

F. RAINBOW TROUT (*S. irideus*).—April 11, received from Mr. Clark 5,000 eggs; repacked and shipped them to the National Fish Culture Association April 18, by steamer Servia. All the eggs sent to England were carried free of charge by the Cunard Line.

Under date of April 21, 1885, Mr. W. Oldham Chambers wrote to Professor Baird as follows:

"I am requested by the council of the National Fish Culture Association to thank you for the very valuable presents of salmon and trout

ova that you have forwarded to this association during the past season, which I am happy to say were hatched out at South Kensington with a very low minimum mortality, and the fry were, in due course, transferred to our fish-culture establishment at Delaford Park, where they continue to thrive."

SCOTLAND.

A. LANDLOCKED SALMON (*S. salar* var. *sebago*).—Received, March 27, one case containing 20,000 eggs. Repacked and shipped to the Tay District Salmon Board, care John Anderson & Son, Royal Emporium, Edinburgh, by steamer State of Pennsylvania, of the State Line, on April 4. Have no advices as to their condition on arrival.

B. RAINBOW TROUT (*S. irideus*).—April 11, received from Mr. Clark 10,000 eggs, and repacked and shipped to Sir James Gibson Maitland, Howetown Fishery, Stirling, by steamer Devonia, of the Anchor Line, April 18. The eggs arrived in good order.

SWITZERLAND.

A. WHITEFISH (*Coregonus clupeiformis*).—January 8, received from Mr. Clark 500,000 eggs. Repacked and shipped them in care of Inspector Coaz, Bern, on January 14, by steamer Amérique, of the General Transatlantic Company. On the 19th of February their safe arrival at Bern was reported to Professor Baird by Hon. Emil Frey, minister from Switzerland. [See letter in Bull. F. C. 1885.]

VII.—REPORT OF OPERATIONS AT THE NORTHVILLE AND ALPENA STATION DURING THE SEASON OF 1884-'85.

By FRANK N. CLARK.

The following report of work at the Michigan stations for the season of 1884-'85 is respectfully submitted.

Table A combines the results of both stations in collecting and distributing eggs and young fish during the year. The supply of eggs was derived from the following sources: Brook and rainbow trout from the breeding stock at Northville ponds; lake trout from the fisheries adjacent to Alpena, Lake Huron; Loch Leven trout from a foreign shipment, through the hands of Fred Mather; grayling from the Manistee and Au Sable Rivers, Northern Michigan; and whitefish from the fisheries of Lake Erie, Lake Huron, and the north shore of Lake Michigan.

TABLE A.—*Summary of eggs and fish handled at the Michigan stations*, 1884-'85.

	Eggs received.	Eggs shipped.	Fish hatched.	Fish shipped.	Fish retained at hatchery.
Brook trout	326, 850	170, 000	20, 000	16, 000	4, 000
Rainbow trout	111, 100	47, 500	12, 000	12, 000	....
Lake trout	465, 000	345, 000	65, 000	65, 000	....
Loch Leven trout	100, 000	55, 000	43, 500	36, 500	7, 000
Grayling	20, 000	5, 000	12, 000	....	12, 000
Whitefish	155, 000, 000	31, 000, 000	88, 000, 000	88, 000, 000	....

The work of the Michigan stations during the past year was essentially similar to that of the preceding one, the chief points of difference being in extent and not in character or methods. The propagation of whitefish was the principal feature of the season's operations, and the field work for this service was largely extended. About 103,000,000 whitefish eggs were laid in at Northville from the fisheries of Lake Erie, including the penning station at Monroe; and 52,000,000 at Alpena from the Lakes Huron and Michigan fisheries. A considerable force of men was required during the spawning season, and they were stationed as follows: Lake Erie—at North Bass, Put-in-Bay, and Catawba Islands, and at Toussaint Creek and Monroe, on the main shore; Lake Huron—at Alcona, Alpena, Round Island, Scarecrow Island,

Presque Isle, Sturgeon Point, Hammond's Bay, Nine-Mile Point, Miller's Point, and Sugar Island; and at Naubinway and Epoufette, north shore of Lake Michigan. The field work of Lake Erie was under the immediate charge of Mr. S. Bower, and of Lake Huron and Michigan, under Mr. S. P. Wires. The weather was very favorable during most of the time of the spawning catch on Lake Erie, but on Lake Huron the work was interrupted November 6th by a heavy northeaster, which destroyed or badly damaged most of the nets set on the west shore, and drove the fish off the shoals. The twine was repaired and replaced to some extent, but the fishing was light, the schools having dispersed or retired to deeper waters. This storm was scarcely felt on Lake Erie. After the storm the supply of eggs for the Alpena house was derived mostly from the fisheries of northern Lake Michigan and from the gill-net fishing on the reefs near Thunder Bay.

The summer and fall catch of whitefish in Lake Erie was much larger than for several seasons. The increase was due to some extent to the favorable weather in the fall, but more to the work of propagation carried on by the United States and State Commissioners, the benefits of which are more apparent here than elsewhere on account of the heavier plantings this lake has received. A large number of Lake Erie fishermen, some of whom were before skeptical regarding the value of propagation, have given testimonials relative to the increased supply of whitefish and expressing their conviction that the increase is simply the legitimate result of the plantings. There is a decided improvement in sentiment in the fishing circles of Lake Erie regarding the practical value of the Commission's work.

The increase in field work made a demand for increased facilities at the Northville station, where the operations of the preceding year were equal to the full capacity of the hatching room and the supply of spring water available for incubating purposes. To meet the demand for more room the equipments of the hatchery were rearranged so as to accommodate more hatching jars, and a number of tanks were constructed and placed in the basement of a creamery building about 10 rods distant from the hatchery. Between the two was placed an elevated reservoir constructed like those in use at railway stations, holding about 160 barrels. This tank was filled with pure water from a small stream about 20 rods distant by means of two steam pumps placed in the boiler-room of the creamery. Suitable pipes conveyed the water from the tank to both hatcheries, the elevated position of the tank giving sufficient pressure to force it to the highest points in both buildings. Two hundred jars of whitefish eggs were placed in the creamery, and carried through to March, when they were transferred to the hatchery after the losses and shipments had made room for them.

The winter being an extremely severe one, the temperature of the creek water seldom rose more than 2 or 3 degrees above the freezing point; consequently the hatching period was from 4 to 6 weeks later than

usual. Heretofore the distribution of whitefish has begun about February 15 to 25; this year the first lot was sent out April 1.

The penning of whitefish (confining them in crates until ripe) was successfully carried on in the Raisin River, near Monroe, Mich., a place well adapted to the purpose. This stream empties into Lake Erie about 2 miles below Monroe, and is navigable for large vessels for about 1½ miles from its mouth. Numerous pound-nets .are set along the coast of the lake above and below the mouth of the river. Hundreds of acres of marsh flank the river on either side nearly to the head of navigation. Several years ago, before the decay of vessel interests at this point, the Government dredged the river to the present head of navigation, and constructed rows of piles or piers on either side a good portion of this distance, to prevent the channel from filling up. The crates of fish were placed alongside of one of these piers, about 80 rods from the lake, in 6 to 8 feet of water. The men in charge were quartered on board a scow, which was fitted up for the purpose and tied to the pier, near the crates. The latter were 6½ by 16 feet in size, and 4½ feet deep, each capable of holding from 400 to 500 fish. The fish were conveyed from the nets to the crates in a "live car," 16 feet long by 3½ feet wide at the bow, 8 feet at the stern, and 4 feet deep. This car was towed by a tugboat sometimes at the rate of 6 miles an hour, and always with perfect safety to its finny passengers. To test the ability of the fish to stand a little crowding, 599 were on one occasion counted into the car from the nets, and then towed in at the usual rate of speed—about 5 miles an hour. On arriving at the pier they were all in excellent condition.

In all, 1,629 fish were placed in the crates, as follows:

October 29	37	November 8	599
October 31	80	November 11	119
November 2	253	November 12	21
November 3	185	November 16	17
November 6	318		

The penned fish were handled with no loss worthy of mention, although it was found necessary to turn over to their owners, Messrs. Dewey & Co., all that were on hand November 25, in order to prevent very serious losses. On November 22 a heavy storm set in from the westward, lasting three days, which blew the water of the lake away from the west shore until the river became so shallow that the men in charge of the crates had to push them into the middle of the channel, and even there they occasionally touched bottom. The river water soon became very muddy and foul, and it was seen that the fish could not stand it long. An attempt was then made to tow the crates out into the lake, where the fish could be kept in good condition until the lake had set back in the channel; but the water was so low that even the tugboats could not get in or out. The fish were then taken in rowboats and delivered at Dewey's fish-house. Such an occurrence has no

parallel in the experience of the oldest fishermen, and as a recurrence is not at all probable we shall continue to use the same place for penning.

Up to the time of the storm the fish were in excellent condition. One hundred and sixty spawners had been stripped, and between five and six million eggs obtained and shipped to Northville, where they were received in good condition. The first eggs from penned fish were taken November 13, and the greatest number from this source in one day was 750,000. The temperature of the water where the crates were placed ranged from 46° on October 2d to 36° on November 25th.

The crate plan was tried on Lake Huron in a limited way at Alcona. One hundred and fifty fish were confined in a crate placed in a well-protected cove near Mr. Hill's fishery, and upward of 1,000,000 eggs were taken from them. This place could be fitted up in first-class shape for penning purposes, at an expense of $800 to $1,000 for dredging and enlarging the cove.

The first whitefish eggs received at Northville arrived from the Lake Erie islands November 13, and the last from the same source came December 1. The largest lot received at one shipment came from the islands on the 15th, consisting of fourteen well-filled cases and eight half-barrels.

Shipments of whitefish eggs from Northville to various States and to foreign countries were much greater than in any previous season, and were very successful, so far as reported, losses being too small to mention.

Below is the table of—

Shipments of whitefish eggs from the Northville station, season of 1884–'85.

Date.	Number.	Consignee.	Condition on arrival.
1884.			
Dec. 24	200,000	E. B. Hodge, commissioner of fisheries, Plymouth, N. H.	Good condition.
24	50,000	Dr. F. B. Tiffany, Kansas City, Mo	Arrived in good condition.
26	1,000,000	Central Station, U. S. Fish Commission, Washington, D. C.	Prime condition.
29	1,000,000	Dr. E. W. Humphreys, commissioner of fisheries, Salisbury, Md.	All in excellent condition.
29	250,000	Otto Gramm, commissioner of fisheries, Laramie City, Wyo.	Not any loss; do not think that there were fifty dead eggs.
30	1,000,000	E. G. Blackford, Fulton Market, New York City.	In good order.
31	1,000,000	Central Station, U. S. Fish Commission, Washington, D. C.	First-class condition.
1885.			
Jan. 5	1,000,000	Ballarat Acclimatization Society, Australia; care of R. J. Creighton, San Francisco, Cal.	Reached Sydney in good condition; nearly all lost in transferring to Melbourne.
7	1,000,000	Fred Mather, Cold Spring Harbor, N. Y., and forwarded to Herr von Behr, Germany.	Reached Germany in good condition.
7	500,000	Fred Mather, to forward to Emil Frey, Switzerland, care of Deutsche Fischerei-Verein.	Arrived at Cold Spring Harbor, N. Y., in good condition.
7	250,000	Fred Mather, to forward to National Fish Culture Association, London, England.	Do.
5	2,500,000	Dr. R. O. Sweeney, commissioner of fisheries, Saint Paul, Minn.	First four lots reported all in excellent order and condition.
8	2,500,000	do	

Shipments of whitefish eggs from the Northville station, &c.—Continued.

Date.	Number.	Consignee.	Condition on arrival.
1884.			
Jan. 12	2,500,000	Dr. R. O. Sweeney, commissioner of fisheries, Saint Paul, Minn.	
13	2,500,000	......do	
19	2,500,000	......do	
20	2,000,500	......do	No report from the last four.
26	2,500,000	......do	
27	2,500,000	......do	
Feb. 4	1,000,000	A. A. Mosher, Spirit Lake, Iowa, for Iowa fish commission.	In splendid order; never saw better.
11	250,000	Agent Smithsonian Institution, Exposition Building, New Orleans.	Received in good condition.
18	1,000,000	Fred Mather, to forward to Herr von Behr, Germany.	Received at Cold Spring Harbor, N. Y., in good condition.
23	500,000	Colonel McDonald, International Exhibit, New Orleans.	Received in good condition.
Mar. 10	1,000,000	R. E. Earll, Government Exhibit, New Orleans Exposition, New Orleans, La.	Do.
	31,000,000		

The distribution of the young whitefish by car was not attended with such uniformly good results as in previous years, through no fault, however, of the superintendent, Mr. Moore, or of his assistants. The car made twelve trips with whitefish, in nine of which no losses worthy of mention occurred. On three trips, however, Mr. Moore reported quite heavy losses, and attributed them in part to the overcrowding of fish that had been kept at the hatchery until they had become weak, and partly to the use of air-tight cans.

It is undoubtedly true that there should be no delay in the planting of whitefish hatched as late as April, as the yelk-sac is so nearly absorbed that it disappears altogether in a few days. It is also equally true that large, open cans are safer and better for large shipments than the closed ones, although the former require much more labor and attention than the latter. Mr. Moore reported the following experiment: "Tried one can without cover, and circulated water same as in other cans. Found fish in better condition than in the closed cans, although twice as many fish were in the open can."

The whitefish hatched at the Alpena station were planted in excellent condition, without any loss in the house or in transit, being near the planting grounds, which are easily accessible by water, except a portion of the trips to Marquette. The fish were carried in large, open cans, and changes of fresh lake water were given them by connecting a hose with the steam-pumps.

Below are the tables of distribution:

FROM NORTHVILLE.

Date of deposit.		Point of deposit.	Number of fish planted.
1885.			
April	2	Lake Michigan, near Ludington, Mich	3,000,000
	8	Lake Michigan, near Milwaukee and Sheboygan, Wis	6,000,000
	11	Lake Erie, near Monroe, Mich	5,000,000
	14	Lake Michigan, near Ludington, Mich	4,000,000
	17	Lake Michigan, near Grand Haven, Mich	4,000,000
	18	Lake Erie, near Monroe, Mich	4,000,000
	20	Detroit River, near Detroit, Mich	4,000,000
	22	Lake Michigan, near Saint Joseph, Mich	4,060,000
	25	Lake Erie, near Monroe, Mich	4,000,000
	27	Lake Erie, near North Bass Island	4,000,000
	29	Lake Michigan, near Milwaukee, Wis	4,000,000
May	1	Detroit River, near Detroit, Mich	4,000,000
			50,000,000

FROM ALPENA.

1885.			
May	2	Lake Huron, near Black River, Mich	3,000,000
	4	Lake Huron, near Oscoda, Mich	3,000,000
	5	Lake Huron, near Sturgeon Point, Mich	3,000,000
	6	Lake Huron, near Alcona, Mich	3,000,000
	7	Lake Huron, near Cheboygan, Mich	3,000,000
	9	Lake Huron, near Scare Crow Isle	3,000,000
	11	Lake Huron, near Mackinac Isle	3,000,000
	14	Lake Superior, near Marquette, Mich	2,000,000
	16	Lake Huron, near Thunder Bay Isle	3,000,000
	18	Lake Huron, near Mackinac Isle	3,000,000
	19	Lake Huron, near Partridge Point, Mich	3,000,000
	20	Lake Superior, near Marquette, Mich	2,000,000
	22	Lake Huron, near Black River Isle	3,000,000
	23	Lake Huron, near Ossineke, Mich	1,000,000
			38,000,000

RAINBOW TROUT.

I am pleased to report a great improvement in the quality of the eggs of this species this season. Heretofore we have usually lost from 75 to 90 per cent of the eggs obtained, but this season more than half the eggs were good. The fish were fed much less, and it is supposed that this accounts for the difference. I am convinced that breeding fish when fed too much will produce weak eggs—that it is better to half starve than to overfeed them. This principle of the effect of high feeding is well understood by stock-breeders, and doubtless applies to fish as well as quadrupeds.

The spawning season opened January 9, and closed April 24. The first eggs were much inferior to the later takings, many of the latter showing 90 per cent good. For the first time at this station, a few eggs were taken from two-year-old trout.

Below are the tables of spawn-taking, shipping of eggs, and disposition of fry:

Daily record of spawn-taking operations in rainbow trout.

Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.
1885.			1885.			1885.			1885.		
Jan. 9	1	700	Feb. 12	1	700	Mar. 12	1	750	Apr. 5	1	800
10	4	4,000	18	2	1,600	13	1	650	6	4	4,000
12	2	2,400	21	1	800	14	1	900	7	6	4,400
13	1	800	22	1	400	15	1	400	8	1	700
15	2	3,000	23	1	600	16	1	700	9	1	900
16	2	2,800	24	3	2,800	17	1	900	11	2	1,400
17	4	5,200	26	1	1,000	18	1	800	13	2	1,600
19	2	1,800	27	2	1,600	19	2	2,100	14	1	400
20	2	2,000	28	3	2,100	23	1	700	18	2	1,800
29	4	3,800	Mar. 1	1	900	26	1	800	19	1	1,000
30	1	1,000	3	2	1,500	27	2	1,600	20	6	5,500
Feb. 2	1	500	4	4	3,100	28	1	900	21	1	1,200
3	2	2,400	5	4	3,200	29	1	1,000	22	1	700
4	4	3,800	6	2	1,400	30	1	600	23	1	800
5	1	1,200	8	1	800	31	3	2,200	24	2	2,100
8	1	500	10	1	1,000	Apr. 3	2	1,800			
9	4	3,700	11	1	600	4	3	2,400	Totals..	126	111,100
10	1	900									

Shipments of rainbow-trout eggs, from the Northville station, season of 1884–'85.

Date.	Number.	Consignee.	Condition on arrival.
1885.			
Mar. 10	2,500	R. E. Earll, Government Exhibit, New Orleans Exposition, New Orleans, La.	Arrived in good condition.
27	10,000	F. Mather, to forward to Herr von Behr, Germany.	Eggs arrived on the 30th and were all in good condition.
Apr. 9	5,000	F. Mather, to forward to National Fish Culture Association, London, England.	Eggs received in good condition.
9	10,000	F. Mather, to forward to Sir James Maitland, Stirling, Scotland.	Received by Mather in good condition.
28	5,000	A. W. Aldrich, fish commissioner, Anamosa, Iowa.	No report.
28	5,000	Dr. R. O. Sweeney, fish commissioner, Saint Paul, Minn.	Do.
30	5,000	I. G. W. Steedman, fish commissioner, Saint Louis, Mo. Re-expressed to R. O. Sweeney, Saint Paul, Minn.	No report.
May 7	5,000	Herschel Whitaker, fish commissioner, Paris, Mich.	Received in good condition.
Total..	47,500		

Shipments of fry of rainbow trout.

Date.	Number.	Delivered to—
1885.		
June 10	10,000	Ransom Townsend, Dicksborough, Mich. Planted in Mosher Spring, near Northville, Mich.
July 7	2,000	
Total..	12,000	

LOCH LEVEN TROUT.

A case of eggs of this species from a foreign consignment through the hands of Fred Mather arrived here January 7, in first-class condition, being as fine a lot of eggs as were ever handled at this station.

There was practically no loss on the eggs, and but a small loss of fry in the tanks. Fifty-five thousand eggs were shipped to other stations and 43,500 fry were hatched. Eggs and fry were disposed of as shown by the following tables:

Shipments of Loch Leven trout eggs.

Date.	Number.	Consignee.	Condition on arrival.
1885.			
Jan. 29	5,000	E. B. Hodge, fish commissioner, Plymouth, N. H.	Eggs came safely and in good condition.
Feb. 3	20,000	A. W. Aldrich, fish commissioner, Anamosa, Iowa.	Eggs came in splendid order; only four dead.
3	20,000	R. O. Sweeney, fish commissioner, Saint Paul, Minn.	No report.
4	10,000	C. G. Atkins, Grand Lake Stream, Me.	On unpacking at Grand Lake Stream they appeared in good condition; only seven dead. In transportation back to Bucksport, however, frost got in and 1,575 eggs were found dead.
Total ..	55,000		

Disposition of fry of Loch Leven trout.

Date.	Number.	Delivered to—
1885.		
Apr. 10	10,000	Michigan Fish Commission.
16	5,000	L. S. Hill & Co., Grand Rapids, Mich. Sent with car No. 2.
16	1,500	G. H. Dalrymple, Grand Rapids, Mich. Sent with car No. 2.
23	20,000	Shipped in charge of car No. 2, and planted in Crooked Lake, near Flint and Pere Marquette Railroad, Northern Michigan.
	7,000	Retained at hatchery for breeding purposes.
Total ..	43,500	

BROOK TROUT.

The first eggs were taken October 12, from the pond of $2\frac{1}{2}$-year-olds, and the last January 5, from the small trout. A few eggs were taken from wild trout caught from the stream near the station and placed in the pond of small trout, but not so many as usual. Below are the tables of spawn-taking and the shipments of eggs and fry:

Daily record of spawn-taking operations in brook trout.

[From trout 20 months old.]

Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.
1884.			1884.			1884.			1884.		
Oct. 26	1	200	Nov. 12	10	2,800	Nov. 29	14	3,200	Dec. 16	6	1,000
29	1	250	13	3	700	30	6	1,000	18	7	900
31	6	950	14	1	300	Dec. 1	5	1,100	19	3	600
Nov. 1	1	225	15	41	8,200	2	28	6,200	23	5	800
2	1	150	16	20	4,800	3	24	5,600	24	4	600
3	4	550	17	16	4,400	4	6	950	27	6	950
4	1	150	18	1	350	5	41	8,400	31	2	400
5	6	1,050	19	12	2,300	6	10	1,800	1885.		
6	5	1,000	20	7	1,600	8	26	5,800	Jan. 2	6	1,000
7	7	1,100	21	8	1,500	9	14	3,200	5	1	350
8	3	500	22	8	1,400	10	12	3,000			
9	1	175	23	20	4,100	11	2	350	Totals.	486	100,250
10	26	5,300	27	9	1,900	12	10	1,800			
11	3	500	28	8	1,800	14	18	3,000			

Daily record of spawn-taking observations in brook trout—Continued.

[From trout 2½ years old.]

Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.
1884.			1884.			1884.			1884.		
Oct. 12	1	50	Nov. 9	12	5,100	Nov. 23	20	9,000	Dec. 9	1	450
19	1	600	10	7	4,200	24	4	2,000	10	2	1,000
24	1	350	11	11	5,200	25	2	800	12	4	1,700
27	2	800	12	3	1,600	27	5	2,200	14	2	650
29	1	500	13	3	1,400	28	10	4,100	16	2	900
31	3	1,600	14	8	3,800	29	7	3,000	18	2	800
Nov. 1	1	1,000	15	10	5,400	30	2	900	21	2	500
2	3	1,900	16	21	11,000	Dec. 1	2	900	23	4	1,400
3	2	1,200	17	15	6,500	2	8	3,000	24	2	600
4	3	2,500	18	2	850	3	6	2,500	27	2	500
5	2	1,800	19	9	4,000	4	8	3,600	29	2	600
6	1	700	20	2	850	5	12	4,800	31	1	400
7	8	4,400	21	7	4,000	6	4	1,800			
8	4	2,200	22	19	9,500	8	3	1,300	Totals.	281	132,400

[From trout 3½ years old and upwards.]

Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.
1884.			1884.			1884.			1884.		
Oct. 21	3	3,000	Nov. 2	2	2,200	Nov. 10	6	5,500	Nov. 18	1	900
24	1	900	3	10	11,000	11	10	8,100	21	2	2,600
25	1	700	4	5	5,200	12	2	2,400	Dec. 9	1	800
28	2	1,800	5	2	1,600	13	2	2,200			
29	1	800	6	2	1,800	14	2	1,000	Totals	93	94,200
30	1	1,600	7	10	12,500	15	2	1,200			
31	5	8,000	8	5	4,000	16	2	1,800			
Nov. 1	6	7,200	9	4	3,200	17	3	2,200			

Shipments of brook-trout eggs.

Date.	Number.	Consignee.	Condition on arrival.
1884.			
Dec. 31	10,000	A. W. Aldrich, commissioner of fisheries, Anamosa, Iowa.	Splendid order.
1885.			
Jan. 28	10,000	John H. Barder, commissioner of fisheries, Rockland, R. I.	Badly frozen; only 2,000 good eggs when they arrived.
28	5,000	Dr. F. B. Tiffany, Kansas City, Mo.	Good condition.
29	10,000	Seth Weeks, superintendent of Western station, Corry, Pa.	No report.
29	10,000	B. E. B. Kennedy, commissioner of fisheries, Omaha, Nebr.	Good; number dead on unpacking, 50.
29	10,000	D. W. Delawder, commissioner of fisheries, Druid Hill Hatchery, Baltimore, Md.	No report.
29	30,000	E. G. Blackford, commissioner of fisheries, Fulton Market, New York City.	Good condition.
Feb. 2	10,000	Dr. Wm. M. Hudson, commissioner of fisheries, Hartford, Conn.	Good condition, but some frozen.
3	10,000	Herschel Whitaker, commissioner of fisheries, Paris, Mich.	Good condition.
4	40,000	F. Mather, to forward to Herr von Behr, Germany.	Reached Mather in good condition.
4	25,000	F. Mather, to forward to National Fish Culture Association, London, England.	Do.
Total..	170,000		

Shipments of brook-trout fry.

Date.	Number.	Delivered to—
1885.		
Apr. 20	3,000	P. B. Tuttle, Niles, Mich.; sent with car No. 2.
23	10,000	Shipped in charge of car No. 2, and planted in north branch of Tobacco River, near Flint and Pere Marquette Railroad, Northern Michigan.
May 4	3,000	J. Elyea, Lawton, Mich.
	4,000	Retained at hatchery for breeding purposes.
Total ..	20,000	

LAKE TROUT.

The supply of lake-trout eggs laid in was considerably larger than usual, and the greater portion was obtained near Thunder Bay, Lake Huron, from runs of fish to the coast reefs. These runs are taken with gill-nets in from 3 to 12 feet of water, the catch, however, being very light as compared with that of the "big reef" of central Lake Huron. The coast trout begin spawning September 15 to 25; the "big reef" trout about a month later.

The increased price obtained for lake trout has wrought a great change in sentiment in fishing circles at Alpena regarding the expediency of the artificial propagation of the species in Lake Huron. A few years ago the fishermen would not allow the eggs to be taken except upon a promise that the young fish should not be returned to the great lakes. It was argued that lake trout were destroying the whitefish by preying on the young, and should therefore be exterminated. But, as the two species are found almost wholly by themselves and on different grounds, it is now claimed that former opinions were largely in error. Whatever weight may be attached to these theories, it is certain that most of the Lake Huron fishermen would not now object to an increased trout supply.

In all, 465,000 eggs were sent to Northville from the Lake Huron fisheries, arriving in good condition. The tables of shipments of eggs and fish are as follows:

Shipments of lake-trout eggs.

Date.	Number.	Consignee.	Condition on arrival.
1884.			
Dec. 22	30,000	A. W. Aldrich, fish commissioner, Anamosa, Iowa.	Eggs came through in very good condition.
22	30,000	Otto Gramm, fish commissioner, Laramie City, Wyo.	Eggs were in splendid condition excepting the ones that were frozen on edges and two bottom trays.
22	10,000	G. W. Delawder, fish commissioner, Druid Hill Hatchery, Baltimore, Md.	No report.
22	20,000	Dr. E. W. Humphries, commissioner of fisheries, Salisbury, Md.	All were in excellent condition.
25	50,000	Central Station, U. S. Fish Commission, Washington, D. C.	Prime condition.
1885.			
Jan. 7	30,000	Fred Mather, to forward to National Fish Culture Association, London, England.	Received by Mather at Cold Spring Harbor, N. Y., in good condition.

Shipments of lake-trout eggs—Continued.

Date.	Number.	Consignee.	Condition on arrival.
1885.			
Jan. 12	50,000	R. O. Sweeney, fish commissioner, Saint Paul, Minn.	Eggs look well; only 130 dead ones.
21	20,000	E. B. Hodge, fish commissioner, Plymouth, N. H.	Eggs came all right and in fine condition.
26	50,000	Wytheville Fish Hatchery, Wytheville, Va.	No report.
27	50,000	William Buller, superintendent Western Station, Corry, Pa.	Good condition.
Feb. 11	5,000	Agent Smithsonian Institution, Exposition Building, New Orleans, La.	Arrived in good condition.
Total	345,000		

Shipments of lake-trout fry.

Date.	Number.	Delivered to—
1885.		
Apr. 18	25,000	Mr. Bassett, Ypsilanti, Mich.
23	15,000	Shipped in charge of car No. 2, and planted in Loon Lake, near Flint and Pere Marquette Railroad, Northern Michigan.
May 4	3,000	J. Elyea, Lawton, Mich.
9	10,000	Agent of N. S. Woodward, Plymouth, Ind.
June 2	10,000	Agent of J. C. Fowle, Michigamme, Mich.
9	2,000	Planted in Long Lake and Huron River, near Northville, Mich.
Total	65,000	

THE GRAYLING.

Having no exact data as to the spawning grounds and the time of spawning of the grayling, the work of taking eggs was largely experimental. Taking these and numerous other difficulties into consideration, the experiment may be considered as fairly successful. Twenty thousand prime eggs were taken, 12,000 on April 18 and 8,000 on April 24. Five thousand eggs were shipped to Central Station, Washington, April 27, and from ten to twelve thousand hatched. Those taken on April 18th hatched May 2 to 5; the others, May 12 to 14; period of incubation, 14 to 20 days; temperature of water, 50° to 62°. Although very successful with the hatching, we were unfortunate with the fry, fully 90 per cent of them dying within two weeks. Most of them refused to take food. The few hundred, however, that pulled through have since done remarkably well, and are now (September 15) twice the size of trout of the same age.

The grayling yields from two to six thousand eggs, according to size. The spawning season was probably later than usual this season, owing to the severe winter and backward spring.

Our operations were conducted on the Manistee and Au Sable Rivers, Northern Michigan. Three men were stationed on the Au Sable, 18 miles east of the village of Grayling, and two men on the Manistee, 12 miles west of Fredericville, moving down stream, later on, to a point about 12 miles west of Grayling. There were still 4 feet of snow in the forests when operations were begun, and it had not wholly disappeared

when the field work closed on April 28. As the route to the camps was traveled for only a portion of the way, communication with them was extremely difficult for the first ten days.

But the greatest trouble of all was to catch the fish, the streams being so completely filled with logs as almost to shut out all chances for fishing. At the rollways, where the logs are put in, the streams are filled from bank to bank with solid tiers for a space of from 10 to 50 rods. Between the rollways the logs were floated in hap-hazard, and one could occasionally catch a glimpse of the river where the logs in floating down had lodged against the bank and formed a temporary bridge. The open spaces in front of these bridges were seldom more than about five rods in extent, and not more than one space to the mile, on an average, could be found. They were also constantly changing, closing up at one point and opening at another, making it unfeasible to operate fyke-nets, or any kind of set-nets. The river was also high and the current too strong to use a seine. Constructing a boom to protect a space was also out of the question, except at a heavy expense, owing to the heavy pressure of logs behind. This was the condition of the Manistee from near the headwaters to a point 60 or 70 miles down, covering, practically, all of the grayling grounds of the main stream. The west branch was also filled with logs.

The men reached camp on the Manistee, near the headwaters, April 10. They remained there eight days, but found no grayling. They then moved down stream 35 miles, where, on the 21st, they found a school in an open space and took 11 of them with hook and line, bottom-fishing. Two of these were full of spawn, but not quite ripe. They were all sent to Northville on the 23d, and the day following the two spawners were stripped and 8,000 prime eggs obtained. The two weighed 20 ounces each. Ten fish were taken from the Manistee after this, all spent. The last day in camp, April 28, three were caught with a fly.

On the Au Sable the men had a better chance, as the logging operations were not so extensive, leaving more and larger spaces. Forty-two grayling were taken from this stream above and below Cheney Bridge, all with hook and line bottom-fishing. As on the Manistee, they were found mostly in the deeper pools, in from 5 to 10 feet of water. The eggs were taken here all in one day, April 18, from fish that had been held in crates from 3 to 14 days. Five fish were stripped and 12,000 good eggs taken. These were shipped to Northville in cans on the 22d, arriving in excellent condition. All the grayling taken from the Au Sable after the 14th were spent; the field was therefore abandoned on the 21st.

With the experience of the past season, we could doubtless obtain many more eggs another year; though the surest way, perhaps, is to catch the fish in the fall when the river is free from logs, and hold them in a suitable place until spawning time. There is an excellent place for this purpose on the Au Sable near Cheney Bridge, and Mr. Thomas

Wakely, a settler living near the river, has promised to try the experiment of holding a score or more through the coming winter.

There is a steady diminution in the number of grayling in their native streams, due to excessive fishing and to the interruption of spawning and hatching by the immense number of logs that are yearly floated, driving the fish from the beds and, in shoal places, destroying the beds themselves. Mr. R. S. Babbitt, of Grayling, an old guide and professional trout and grayling fisherman, says there is not now one grayling where there were a hundred ten years ago. It is believed by the residents of the grayling region that if the species is not protected or propagated, it will soon become extinct. This would certainly be a great misfortune, as the grayling is unsurpassed for game and table qualities by any of the freshwater species. Railroad companies whose lines reach the region where it abounds advertise this fact as a leading attraction for tourists, and the grayling has taken no small part in the settlement and improvement of the region of its habitat.

Record of temperature observations made at the Northville station from November 1, 1884, to May 1, 1885.

Date.	Temperature of water.			Temperature of air.			Direction of wind.			Intensity of wind.			Condition of sky.		
	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.
1884.	°F.	°F.	°F.	°F.	°F.	°F.									
Nov. 1	47	48	48	40	44	40	W.	SW.	W.	Calm	Light	Light	Cloudy	Cloudy	Cloudy.
Nov. 2	46	47	46	30	36	38	W.	SW.	SW.	Light	do	do	Clear	Clear	Clear.
Nov. 3	44	46	47	26	36	44	S.	W.	W.	Calm	do	Calm	do	do	Do.
Nov. 4	46	45	46	40	38	36	NE.	NW.	NW.	Light	do	do	Cloudy	Cloudy	Cloudy.
Nov. 5	44	44	44	34	46	32	NW.	N.	NW.	do	Brisk	do	do	Clear	Clear.
Nov. 6	40	40	42	26	39	30	NW.	NW.	SW.	do	Light	do	Clear	do	Do.
Nov. 7	40	42	45	32	53	48	SW.	W.	NW.	do	do	do	do	do	Do.
Nov. 8	42	45	47	24	40	44	NW.	S.	S.	do	do	do	do	do	Do.
Nov. 9	44	46	48	24	56	52	NW.	SW.	SW.	do	do	do	do	do	Do.
Nov. 10	46	49	50	44	59	49	SW.	NW.	W.	do	do	do	do	do	Do.
Nov. 11	48	48	48	42	41	42	NW.	SW.	SW.	do	do	do	Cloudy	Cloudy	Cloudy.
Nov. 12	47	46	46	36	40	32	SW.	SW.	W.	Calm	Calm	do	do	do	Do.
Nov. 13	44	46	47	34	51	38	SW.	NW.	NW.	do	do	do	do	Clear	Clear.
Nov. 14	44	46	47	26	54	40	NW.	NW.	SW.	do	do	do	Clear	do	Do.
Nov. 15	44	47	48	36	58	32	W.	SW.	W.	do	do	do	do	do	Do.
Nov. 16	44	48	48	31	64	44	W.	SW.	S.	do	do	do	do	do	Do.
Nov. 17	48	47	44	39	34	28	N.	N.	E.	Light	Light	do	Cloudy	Cloudy	Cloudy.
Nov. 18	40	41	41	26	31	28	NE.	E.	E.	do	do	Light	do	do	Do.
Nov. 19	40	41	41	22	34	26	NE.	NW.	S.	do	do	do	Clear	Clear	Clear.
Nov. 20	40	41	41	30	39	32	S.	SW.	SW.	do	do	do	do	do	Do.
Nov. 21	40	42	44	28	42	36	SW.	SW.	S.	do	do	do	do	do	Do.
Nov. 22	40	44	42	29	51	44	N.	S.	S.	do	do	do	do	do	Do.
Nov. 23	42	48	32	32	42	30	SW.	SW.	NW.	Brisk	do	do	do	Cloudy	Cloudy.
Nov. 24	36	36	34	13	18	14	W.	W.	SW.	do	Brisk	Brisk	Rain	Clear	Clear.
Nov. 25	36	36	38	24	34	28	SW.	SW.	W.	Light	Light	do	Clear	do	Do.
Nov. 26	36	37	38	20	29	18	SW.	SW.	S.	do	do	Light	do	do	Do.
Nov. 27	36	38	39	24	37	31	SW.	E.	E.	do	do	do	do	do	Do.
Nov. 28	36	38	40	25	38	29	N.	W.	NW.	do	do	do	do	do	Do.
Nov. 29	38	40	39	24	34	29	W.	W.	S.	do	do	do	do	do	Do.
Nov. 30	38	40	40	21	27	12	N.	N.	NW.	do	do	do	do	do	Do.
Dec. 1	38	38	40	18	36	16	W.	S.	S.	do	do	do	do	do	Do.
Dec. 2	38	38	40	8	35	18	W.	S.	SW.	do	do	do	do	do	Do.
Dec. 3	38	40	42	21	42	28	S.	S.	S.	do	do	do	do	do	Do.
Dec. 4	40	41	42	28	46	34	S.	S.	S.	do	do	do	do	do	Do.
Dec. 5	44	46	46	38	50	46	S.	S.	S.	do	do	do	do	do	Cloudy.
Dec. 6	47	48	48	44	46	47	E.	E.	N.	Calm	do	do	do	Cloudy	Do.
Dec. 7	46	46	44	40	40	36	W.	W.	W.	Light	Brisk	do	Cloudy	do	Do.
Dec. 8	45	42	42	34	35	34	W.	W.	W.	do	do	do	do	do	Do.
Dec. 9	40	40	40	28	36	30	W.	W.	W.	do	do	do	Clear	do	Do.
Dec. 10	40	40	40	24	40	36	SW.	SW.	SW.	do	do	do	do	do	Do.
Dec. 11	42	42	41	30	35	30	W.	W.	N.	do	do	do	do	do	Clear.

Dec. 12	39	39	39	28	30	26	NE.	NE.	NE.	....do	Light	Calm	...do	Clear	Cloudy.
Dec. 13	38	24	39	28	34	29	NW.	SW.	SW.	....do	....do	....do	....do	....do	Do.
Dec. 14	39	39	40	28	36	29	SE.	S.	SW.	....do	....do	....do	....do	....do	Do.
Dec. 15	38	37	38	29	27	25	NW.	S.	W.	Brisk	... do	... do	Snow	Snow	Snow.
Dec. 16	35	34	37	18	28	20	SW.	SW.	SW.	....do	....do	....do	Clear	Clear	Clear.
Dec. 17	35	36	38	10	17	3	NW.	NW.	W.	....do	Brisk	Brisk	....do	....do	Do.
Dec. 18	38	38	38	− 8	8	− 2	NW.	NW.	NW.	....do	....do	....do	....do	....do	Do.
Dec. 19	37	38	38	−12	14	−10	W.	NW.	W.	....do	....do	....do	....do	....do	Do.
Dec. 20	37	38	38	− 3	20	16	E.	S.	S.	....do	Calm	Calm	....do	....do	Do.
Dec. 21	38	38	38	20	28	22	NW.	NE.	S.	Calm	....do	Brisk	....do	....do	Do.
Dec. 22	39	38	38	26	24	14	W.	W.	W.	....do	....do	Calm	....do	....do	Do.
Dec. 23	38	38	38	− 2	29	14	W.	SW.	S.	Brisk	....do	....do	....do	....do	Do.
Dec. 24	38	38	38	14	27	11	E.	W.	NW.	Calm	....do	Brisk	....do	....do	Do.
Dec. 25	38	36	36	2	13	10	N.	NE.	NE.	Brisk	...do	....do	....do	....do	Do.
Dec. 26	38	38	36	Zero.	20	10	NE.	E.	E.	....do	....do	...do	....do	....do	Do.
Dec. 27	36	38	38	8	32	26	NW.	SE.	E.	... do	....do	Calm	....do	....do	Do.
Dec. 28	38	40	40	36	46	38	SW.	S.	S.	Calm	....do	....do	Cloudy	Cloudy	Cloudy.
Dec. 29	42	40	40	36	46	39	E.	SW.	SE.	....do	....do	....do	Clear	Clear	Do.
Dec. 30	42	42	42	37	44	44	NW.	E.	SW.	.. do	....do	....do	Cloudy	Cloudy	Do.
Dec. 31	42	43	42	30	34	27	W.	W.	SW.	.. do	....do	....do	Clear	Clear	Do.
1885.															
Jan. 1	35	36	35	18	23	14	NW.	NW.	W.	....do	... do	....do	....do	....do	Clear.
Jan. 2	33	36	36	3	16	16	NW.	W.	SW.	Brisk	Brisk	....do	....do	....do	Do.
Jan. 3	36	36	37	12	24	23	SW.	SW.	SW.	....do	....do	....do	....do	.. do	Do.
Jan. 4	37	38	38	23	34	28	SW.	SW.	SW.	Light	Light	....do	Cloudy	....do	Do.
Jan. 5	37	37	36	25	44	34	SW.	SW.	SW.	....do	....do	....do	Clear	.. do	Do.
Jan. 6	36	38	38	38	45	38	SE.	SW.	W.	....do	....do	....do	Cloudy	Cloudy	Cloudy.
Jan. 7	37	38	40	32	38	34	W.	SW.	W.	....do	....do	.. do	....do	....do	Clear.
Jan. 8	40	40	42	32	42	34	SW.	S.	SW.	...do	....do	..do	....do	Clear	Do.
Jan. 9	40	40	39	35	39	26	W.	NW.	NW.	....do	....do	Brisk	Clear	....do	Do.
Jan. 10	34	36	39	16	34	39	N.	SW.	SW.	....do	....do	Calm	....do	....do	Do.
Jan. 11	38	38	39	32	38	37	SW.	SW.	S.	.. do	.. do	....do	....do	Cloudy	Cloudy.
Jan. 12	38	37	36	28	28	24	NW.	NW.	NW.	....do	Brisk	Brisk	Cloudy	Clear	Clear.
Jan. 13	33	34	36	6	18	14	NW.	NW.	SW.	Brisk	....do	....do	Clear	....do	Do.
Jan. 14	36	36	37	10	26	27	SW.	W.	SE.	....do	Light	Light	....do	....do	Do.
Jan. 15	36	37	36	22	31	42	E.	NE.	NE.	Light	....do	.. do	....do	....do	Do.
Jan. 16	36	36	35	19	23	28	NE.	NE.	NE.	....do	....do	....do	....do	....do	Snow.
Jan. 17	34	32	33	8	15	16	NW.	NW.	NW.	Brisk	Brisk	Brisk	... do	....do	Clear.
Jan. 18	32	34	35	− 6	8	2	SW.	SW.	SW.	....do	....do	....do	....do	....do	Do.
Jan. 19	34	34	34	−21	16	2	NW.	SW.	SW.	....do	....do	....do	....do	....do	Do.
Jan. 20	34	34	34	− 8	9	3	NW.	SW.	SW.	....do	....do	....do	....do	....do	Do.
Jan. 21	34	35	34	0	19	2	SW.	NW.	NW.	....do	Light	....do	....do	....do	Do.
Jan. 22	34	34	35	−14	14	− 4	SW.	SW.	SW.	....do	.. do	....do	....do	....do	Do.
Jan. 23	34	34	34	9	24	20	SW.	SW.	S.	Light	... do	Light	....do	....do	Do.
Jan. 24	35	36	36	24	35	28	E.	SW.	W.	....do	do	....do	....do	....do	Do.
Jan. 25	36	36	36	26	32	8	NW.	W.	SW.	....do	... do	....do	....do	....do	Do.
Jan. 26	34	34	34	5	12	− 1	W.	SW.	SW.	....do	....do	Brisk	....do	... do	Do.
Jan. 27	34	34	34	− 2	5	− 4	S.	E.	NE.	....do	....do	....do	....do	....do	Do.
Jan. 28	34	34	34	−14	16	0	W.	SW.	SW.	Brisk	... do	....do	....do	...do	Do.
Jan. 29	34	34	34	−18	11	2	SW.	SW.	SW.	....do	Brisk	Light	....do	....do	Do.
Jan. 30	36	35	36	20	34	24	S.	NW.	N.	Light	Light	....do	....do	....do	Do.

Record of temperature observations made at the Northville station from November 1, 1884, *to May* 1, 1885—Continued.

Date.	Temperature of water.			Temperature of air.			Direction of wind.			Intensity of wind.			Condition of sky.		
	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.	8 a. m.	12 m.	5 p. m.
1885.	°F.	°F.	°F.	°F.	°F.	°F.									
Jan. 31	34	35	36	0	26	20	NE.	E.	SW.	Light	Light	Light	Clear	Clear	Clear.
Feb. 1	35	35	34	17	22	−2	NW.	NW.	N.	...do	...do	Brisk	...do	...do	Do.
Feb. 2	33	34	34	−2	16	10	SW.	SW.	SW.	Brisk	Brisk	...do	...do	Cloudy	Snow.
Feb. 3	34	35	36	23	37	31	SW.	SE.	SE.	Light	Light	Light	...do	Clear	Clear.
Feb. 4	36	36	36	33	40	32	SW.	NW.	NW.	...do	...do	...do	...do	...do	Do.
Feb. 5	35	34	34	12	12	0	N.	NW.	N.	...do	...do	...do	...do	...do	Do.
Feb. 6	33	34	34	−10	20	8	NE.	SE.	E.	Brisk	...do	...do	...do	...do	Do.
Feb. 7	34	34	35	6	23	20	E.	E.	SE.	Light	...do	...do	...do	...do	Snow.
Feb. 8	34	35	35	28	28	16	NW.	E.	NE.	Calm	...do	...do	Cloudy	...do	Clear.
Feb. 9	34	34	34	13	18	18	E.	NE.	NW.	Brisk	...do	...do	...do	Cloudy	Snow.
Feb. 10	32	32	32	−9	7	−13	NW.	NW.	NW.	Strong	High	Gale	...do	...do	Do.
Feb. 11	32	32	32	−22	−2	−3	NW.	NW.	W.	Brisk	Brisk	Light	...do	...do	Do.
Feb. 12	32	33	34	0	10	−4	SW.	SW.	W.	Light	...do	Brisk	...do	Clear	Clear.
Feb. 13	34	34	34	−29	15	−3	W.	SW.	SW.	Brisk	...do	...do	Clear	...do	Do.
Feb. 14	34	34	34	−14	28	10	NE.	SE.	SE.	...do	Light	Light	...do	...do	Do.
Feb. 15	34	34	34	14	36	34	SE.	S.	SW.	...do	Brisk	...do	...do	...do	Do.
Feb. 16	34	34	34	−4	4	−9	SW.	SW.	SW.	...do	...do	...do	...do	...do	Do.
Feb. 17	34	34	34	−14	6	4	SW.	SW.	SW.	...do	...do	...do	...do	...do	Do.
Feb. 18	34	34	34	−8	16	10	W.	NW.	W.	Light	Light	...do	...do	...do	Do.
Feb. 19	34	34	34	3	17	5	SW.	SW.	NW.	...do	...do	...do	...do	...do	Do.
Feb. 20	34	34	34	−4	20	0	W.	SW.	W.	...do	...do	...do	...do	...do	Do.
Feb. 21	34	34	34	−2	21	7	SW.	SW.	NW.	...do	...do	Calm	...do	...do	Do.
Feb. 22	34	34	34	4	22	4	NW.	NW.	NW.	...do	...do	...do	...do	Cloudy	Cloudy.
Feb. 23	34	34	34	−12	32	14	NW.	SW.	SW.	Calm	...do	...do	...do	...do	Do.
Feb. 24	34	34	34	9	32	26	W.	E.	E.	Light	...do	Light	Cloudy	...do	Do.
Feb. 25	34	34	34	6	37	26	NE.	SE.	E.	...do	...do	...do	Clear	Clear	Clear.
Feb. 26	35	35	35	22	44	31	E.	S.	SW.	...do	...do	...do	Cloudy	Cloudy	Cloudy.
Feb. 27	34	36	34	26	44	30	SW.	NW.	SW.	...do	...do	...do	Clear	Clear	Clear.
Feb. 28	36	37	36	24	50	38	NE.	S.	SW.	...do	...do	...do	...do	...do	Do.
Mar. 1	36	36	36	36	40	30	NW.	W.	NW.	...do	...do	...do	Cloudy	Cloudy	Cloudy.
Mar. 2	33	35	36	18	34	29	NW.	NW.	NW.	...do	...do	...do	Clear	Clear	Clear.
Mar. 3	36	38	37	32	48	36	SW.	SW.	SW.	...do	...do	...do	Cloudy	...do	Cloudy.
Mar. 4	36	38	37	34	40	32	W.	NW.	NW.	...do	...do	...do	...do	Cloudy	Do.
Mar. 5	38	39	42	27	33	36	NW.	E.	NW.	...do	...do	...do	...do	Clear	Clear.
Mar. 6	38	42	42	22	40	30	E.	E.	E.	...do	...do	...do	...do	...do	Do.
Mar. 7	36	38	39	16	27	17	NW.	NW.	NW.	Brisk	...do	...do	...do	...do	Cloudy.
Mar. 8	36	39	39	4	26	10	NW.	W.	NW.	...do	...do	Brisk	Clear	...do	Do.
Mar. 9	37	38	38	20	38	38	SW.	SW.	NW.	...do	Brisk	Light	...do	...do	Clear.
Mar. 10	36	38	39	15	22	16	N.	NW.	N.	Light	Light	...do	...do	...do	Do.
Mar. 11	38	39	40	10	32	32	E.	SW.	S.	...do	...do	...do	...do	...do	Do.
Mar. 12	38	39	39	22	24	16	E.	NE.	NE.	...do	...do	...do	Cloudy	Cloudy	Cloudy.

Mar. 13	38	38	38	4	28	24	SW.	SW.	SW.	....do	....do	....do	....do	....do	Snow.
Mar. 14	37	38	39	24	44	39	SE.	S.	SW.	....do	.. do	....do	....do	....do	Do.
Mar. 15	35	37	38	20	28	24	NW.	NW.	W.	....do	....do	....do	....do	Clear	Clear.
Mar. 16	36	37	38	0	6	7	N.	N.	NW.	Brisk	Brisk	....do	Clear	....do	Do.
Mar. 17	34	38	38	−10	17	12	NW.	W.	SW.	....do	Light	Brisk	....do	....do	Do.
Mar. 18	36	37	38	16	39	18	SW.	SW.	N.	Light	....do	Light	....do	....do	Cloudy.
Mar. 19	34	36	37	5	16	12	SW.	NW.	N.	Brisk	....do	....do	....do	....do	Do.
Mar. 20	33	34	35	−10	11	5	N.	SW.	NW.	....do	Brisk	....do	....do	....do	Clear.
Mar. 21	34	35	38	− 4	16	12	NW.	NW.	NW.	....do	Light	....do	....do	....do	Do.
Mar. 22	36	38	38	− 2	18	17	NE.	NE.	N.	Light	....do	....do	....do	....do	Do.
Mar. 23	36	38	39	0	27	23	NW.	SW.	SW.	....do	....do	....do	....do	....do	Do.
Mar. 24	36	38	39	28	37	31	SW.	NW.	N.	....do	....do	....do	Cloudy	Cloudy	Cloudy.
Mar. 25	35	38	38	0	34	29	W.	SW.	SW.	....do	....do	....do	Clear	Clear	Clear.
Mar. 26	38	40	39	32	48	42	SW.	SW.	SW.	....do	....do	....do	....do	....do	Do.
Mar. 27	42	44	46	38	44	38	SW.	NW.	NW.	....do	....do	....do	Cloudy	Cloudy	Cloudy.
Mar. 28	39	44	46	30	44	32	E.	E.	SE.	....do	....do	....do	Clear	Clear	Do.
Mar. 29	39	44	47	20	34	32	E.	NE.	SW.	....do	Calm	Calm	Cloudy	....do	Do.
Mar. 30	42	40	42	34	40	34	S.	SW.	SW.	....do	....do	....do	....do	Cloudy	Do.
Mar. 31	39	44	48	46	48	43	SW.	W.	W.	Calm	....do	....do	Clear	Clear	Clear.
Apr. 1	40	46	47	55	48	34	N.	E.	E.	....do	....do	....do	..do	....do	Do.
Apr. 2	42	43	43	32	44	38	E.	SW.	N.	....do	....do	....do	Cloudy	Cloudy	Cloudy.
Apr. 3	35	37	39	25	32	31	NE.	NE.	NE.	Light	....do	....do	....do	....do	Do.
Apr. 4	35	40	46	34	43	42	NE.	W.	W.	....do	....do	....do	Clear	Clear	Clear.
Apr. 5	42	49	52	36	60	51	SW.	W.	NW.	Calm	Light	Light	Cloudy	....do	Do.
Apr. 6	44	50	54	38	56	44	N.	S.	E.	....do	Calm	....do	Clear	....do	Do.
Apr. 7	46	47	50	43	56	55	SW.	SW.	SW.	Light	....do	Calm	Cloudy	Cloudy	Cloudy.
Apr. 8	46	46	47	34	34	30	NW.	NW.	NW.	Strong	Brisk	Light	....do	Clear	Do.
Apr. 9	40	44	45	26	40	32	E.	SE.	SE.	Light	Calm	....do	.. do	Cloudy	Clear.
Apr. 10	40	46	46	22	47	30	SE.	SW.	SE.	Calm	Light	....do	Clear	Clear	Do.
Apr. 11	41	43	42	37	39	33	SE.	NW.	NW.	....do	....do	....do	Snow	Cloudy	Snow.
Apr. 12	40	42	45	33	40	36	NW.	S.	S.	Light	....do	... do	Cloudy	Clear	Cloudy.
Apr. 13	39	39	39	26	30	32	NW.	NW.	NW.	Strong	Strong	Brisk	....do	Cloudy	Do.
Apr. 14	38	40	42	21	42	31	N.	SW.	SE.	Light	Calm	Light	....do	....do	Do.
Apr. 15	39	42	46	32	49	39	SE.	SE.	SE.	....do	....do	Calm	... do	....do	Do.
Apr. 16	44	45	47	36	40	35	SE.	NE.	NE.	....do	Brisk	Light	....do	....do	Do.
Apr. 17	42	46	48	35	38	36	NE.	NE.	NE.	Brisk	....do	....do	....do	....do	Do.
Apr. 18	44	47	49	42	49	46	SE.	SE.	SE.	....do	....do	....do	.. do	....do	Do.
Apr. 19	45	47	56	65	70	70	SW.	SW.	SW.	Light	Light	....do	Clear	Clear	Clear.
Apr. 20	52	56	54	48	77	72	E.	SW.	SW.	....do	....do	....do	....do	.. do	Do.
Apr. 21	52	60	62	60	80	75	SW.	SW.	SW.	....do	....do	....do	Cloudy	.. do	Do.
Apr. 22	54	60	57	68	76	73	E.	SW.	SW.	Calm	....do	Brisk	Clear	Cloudy	Do.
Apr. 23	55	62	64	64	78	78	SW.	SW.	SW.	....do	Brisk	Light	....do	Hazy	Hazy.
Apr. 24	56	56	56	55	60	59	NW.	NW.	NW.	Light	Light	....do	Rain	....do	Clear.
Apr. 25	47	50	54	49	60	57	NE.	SE.	SE.	....do	Brisk	Brisk	Clear	....do	Hazy.
Apr. 26	48	53	50	47	59	54	NW.	N.	N.	.. do	....do	....do	....do	....do	Do.
Apr. 27	49	55	57	49	60	70	N.	NW.	NW.	... do	Light	Light	....do	....do	Do.
Apr. 28	50	50	48	54	41	43	W.	N.	N.	....do	Brisk	Brisk	Cloudy	Cloudy	Cloudy.
Apr. 29	45	52	52	44	65	60	NW.	SW.	SW.	....do	Light	Light	Clear	Clear	Clear.
Apr. 30	51	51	52	54	57	53	N.	SE.	SE.	....do	....do	....do	Cloudy	Rain	Rain.

VIII.—REPORT OF OPERATIONS AT THE U. S. SALMON-BREEDING STATION, ON THE M'CLOUD RIVER, CALIFORNIA, DURING THE SEASON OF 1884.

By Livingston Stone.

During the summer of 1883 the Central Pacific Railroad Company was engaged in building a road from Redding, Cal., northward up the line of the Sacramento River. The heavy blasting involved in the construction operations of the railroad company, near the mouth of Pitt River, had the effect of destroying or stopping nearly all the salmon which would have ascended the Pitt River, of which the McCloud River is a tributary. The consequence was that it became impossible to take the usual number of salmon eggs at the McCloud Station. Indeed, it was with great difficulty, and only by persevering efforts under great discouragements, that enough parent fish could be caught to yield the extremely small number of a million salmon eggs.

Owing to these circumstances, it was thought best to intermit operations at this station for this season. Accordingly, nothing has been done here this year except to leave things *in statu quo*, and to keep the property belonging to the Commission in safety, the only current expenses being for the salary of the janitor in charge of the property, and for some slight repairs, the whole not exceeding, I believe, $400. No losses nor disasters of any kind have occurred during the year.

It should be mentioned, however, that the large current-wheel which furnishes the water supply for the hatching-house was completely wrecked by an accident which happened last year. In replacing it, it will probably be necessary to build two new flat-boats to support it, the cost of all of which is estimated at $800. Various plans for raising an adequate water supply to the hatching-house have been suggested, but none of them seem to be practicable, and it will undoubtedly be necessary to build a new current-wheel before operations can be satisfactorily renewed at this station. With the exception just mentioned, the station and all its equipments at the time of making this report (October, 1884) are in good condition.

Charlestown, N. H., *October* 30, 1884.

IX.—REPORT OF OPERATIONS AT THE TROUT-BREEDING STATION ON THE M'CLOUD RIVER, CALIFORNIA, DURING THE SEASON OF 1884.

By LIVINGSTON STONE

The date of the beginning of the spawning season at the trout ponds seems to recede a little every year. This season, the first ripe fish were found on the 28th of December, when 12,300 eggs were taken from 16 trout. The spawning continued till the 28th of May, when 8,000 eggs were taken from 10 trout. Mr. Loren W. Green, who has charge of this station, reports that there were still many unripe females at that time which had not spawned, and which he had to turn back to the ponds because no more ripe males could be obtained, the spawning season for the males being entirely over. Mr. Green also reports that there was something very unusual in the way in which the spawning females turned out this season; their eggs not only seemed to be very slow in maturing in the parent, but they were also few in number, small and poorly developed when ripened. The average number of eggs to the fish was at least 200 less than in former years. The observations of Mr. Green were confirmed by the experience of Mr. J. B. Campbell, who has been engaged in the culture of trout, more or less, for the last eight years. Mr. Campbell writes, under date of May 17, 1884, that there has never been such a season on the river since he took up trout culture there eight years ago. The trout, he says, did not yield the usual number of eggs, and they acted strangely in running up the small streams many days before they were ready to spawn. Mr. Green attributes much of this unusual conduct on the part of the trout to scarcity of food in the river during the fall. The thousands of salmon which annually die in the river at their spawning season, and then sink to the bottom, furnish, strangely enough, much of the food of the trout at that season, besides vastly increasing the amount of low forms of aquatic animal life in the river, which also furnish food for the trout later on. This year, very few salmon came up the river, owing to the blasting operations of the railroad construction corps, near the mouth of Pitt River, and the natural food supply of the McCloud River trout was consequently very much diminished. I think Mr. Green is correct in connecting the peculiar conduct of the parent trout with this diminution of the food supply,

though other causes, perhaps now unknown, probably complicated the matter and contributed to produce the general effect.

During the latter part of January there was a very heavy fall of rain, such a rain-storm, indeed, as I suppose is encountered only in mountainous regions like this. The McCloud River rose rapidly, the mud poured down the trout-pond creek, and, although Mr. Green was at work to protect them two entire nights, 35,000 trout eggs in the hatching-troughs were killed by the excess of mud in the water. The storm is described as a terrific one, and did some other damage about the station, which, however, was soon repaired.

After the storm, the season proved as usual, with the exception of the peculiarities above mentioned of the spawning trout. Notwithstanding the difficulties which had to be contended with this year, upward of 315,000 trout eggs were taken, most of which were sent to the States of the Atlantic Slope, though some were given to the California Fish Commission, some hatched and returned to the McCloud River, and some hatched and kept to be reared at the station.

Below will be found notes from Mr. Green's diary, and tables of statistics, as follows:

(*a*) Table giving daily number of fish spawned and eggs taken.

(*b*) Table showing the distribution of the eggs taken.

(*c*) Table giving temperatures of air and water.

CHARLESTOWN, N. H., *October* 30, 1884.

NOTES FROM DIARY OF MR. LOREN W. GREEN, SUPERINTENDENT OF McCLOUD RIVER TROUT-BREEDING STATION, CALIFORNIA, EXTENDING FROM DECEMBER 23, 1883, *TO APRIL* 18, 1884.

Dec. 23. Rain and snow all day.
24. Raining all day; river rising.
25. Raining hard all day, water 2 feet high.
26. Raining all day, water about the same. Snow on mountains.
27. Went over fish in the upper pond to-day. Got 10 ripe females. Raining hard. Fish commenced to spawn.
28. Raining hard all day. No ripe fish.
29. No ripe fish. No rain, but cloudy.
30. No ripe fish. A few fish ran up race, but no ripe ones.
31. Forty-nine fish ran up the race. Not one ripe or showing any signs of spawning.

Jan. 1. Ten trout ran up race. Two ripe females and one ripe male.
2. A few fish ran up. No ripe ones.
3. No ripe fish.
4. No ripe fish.
5. Heavy rain all day.
6. Went over fish in lower pond—got several ripe females, and found 40 females spawned out; fish spawning very few eggs.
7. Raining hard all day. Put trap in Hirtz Creek this evening.
8. Raining hard all day; finished trap at Hirtz Creek.
9. Caught 3 trout in trap; clear and cool.
10. No trout in traps; freezing hard to-night.

Jan. 11. No trout in traps; clear and cool.
12. Freezing hard nights; no fish.
13. Weather cold and clear; no fish.
14. Weather cold and clear; no fish.
15. Weather cold and clear; no fish.
16. Weather cold and clear; no fish.
17. Took out trap and closed up race.
18. Weather cool and clear.
19. Weather cloudy.
20. Weather cloudy and cold.
21. Weather cloudy and warm.
22. Weather cloudy and warm.
23. Water in creek very low; no fish.
24. Weather cool and clear; trout spawning very poorly.
25. Shipped eggs; weather clear and cool.
26. Raining hard all day.
27. Raining hard all day; creek very high and muddy to-night.
28. Raining hard; heavy land-slide up the creek; ponds filling with mud very fast, and eggs dying very fast.
29. Ground covered with snow; water clearer. Latest eggs taken nearly all dead; those a week old all right and alive; those dead were one day old before the muddy water.
30. Weather clear and warmer; water clearing up fast; water in river very high.
31. Fish-traps all washed away; weather clear and water falling; eggs doing well.

Feb. 1. Put traps back in the creek to-day. Caught 2 trout this evening.
2. Caught 2 trout in trap; sent Indians up to Wye-te-Wouet to put in trap to-day.
3. Caught 2 trout in traps; weather cloudy and unsettled.
4. Caught 7 trout in traps. Forenoon showery; evening clear and cold.
5. Caught 1 trout; heavy snow-storm.
6. Very cold. Water falling fast.
7. Eggs doing well; very cold, thermometer at 6 p. m. 20° above zero.
8. Very cold. Eggs advancing very slowly; eggs twenty days old showing no eye spots.
9. Very cold.
10. Sunday very cold. Eggs advancing very slowly. Clear and pleasant.
11. Sent Indians to Chattedouchekilles to put in wood trap in creek.
12. Weather very cold. No fish running.
13. Went to Big Creek, but no fish.
14. Packed in some ice; very thin and poor.
15. Snow 8 inches deep, and very cold.
16. Raining hard all day. Caught 3 trout.
17. Raining hard; water raising very fast. Caught 10 trout.
18. Raining hard; water very high and muddy; traps washed away. No trout to-day.
19. Weather colder; snowing very hard, water very high and muddy; snow 10 inches deep here on the river and still snowing.
20. Snowing hard in morning, evening clear and sun shining brightly; water falling.
21. Weather clear and warmer; water at a standstill; mud 8 inches deep in pond.
22. Clear and warm; no fish.
23. Water falling fast; no fish running.
24. Packed and shipped 18,000 eggs to Washington.

Feb. 25. Weather clear and warm.
26. Went up the river to traps; no fish.
27. Fish spawning very slowly, and very few eggs.
28. Caught 3 trout; clear and warm.
29. Clear and warm.

Mar. 1. Clear and warm.
2. Tuesday, shipped eggs to Washington.
3. Weather cloudy and warm.
4. Weather cloudy and warm.
5. Raining hard all day; water rising very fast and very muddy.
6. Raining hard in forenoon; afternoon clear, and evening very cold; fish advancing very slowly.
7. Very cloudy and warm.
8. Raining hard all day; warm.
9. Raining very hard all day; water very high and muddy; eggs covered with mud. We are washing them every 15 minutes; they are doing well so far.
10. Clear and warm; water falling a little.
12. Clear and warm; water falling a little.
13. Weather very dark and cloudy.
14. Raining all day.
15. Weather cloudy; heavy showers in evening.
16. Weather very dark and cloudy.
17. Raining hard all day.
18. Weather clear and cool; trout spawning very badly and eating freely.
19. Picked out trout for Fulton market exhibition.
20. Fish act very strangely—spawning very slowly, and very few eggs.
21. Went to Redding and shipped trout to New York; weather showery.
22. Raining hard all day.
23. Clear and cold.
24. Very cloudy; raining in evening.
25. Raining hard all day; very cool.
26. Misty and dark; weather cool.
27. Snowing hard all day; very cold; 8 inches of snow this evening.
28. Raining hard all day; water high.
29. Snow all gone and clear.
30. Went over fish. They seem no nearer spawning than 4 weeks ago; are acting very strangely.
31. Clear all day; cloudy in evening.

April 1. Raining hard all day.
2. Raining hard all day.
3. Clear and cool.
4. Caught 6 trout up at Chattedouchekilles.
5. Male trout all ripe; females not ripe.
6. Weather clear. Caught 14 trout in trap up at Chattedouchekilles.
7. Caught 8 trout.
8. Caught 20 trout.
9. Raining hard all day; trout all running over trap.
10. Raining hard all day.
11. Raining hard, and water very high.
12. Raining hard; creeks just booming.
13. Raining hard all day.
14. Raining hard all day.
15. Raining forenoon; afternoon clear.
16. Water falling fast; ponds filled about 12 inches with mud.
17. Weather clear and warm.
18. Weather clear and warm.

Daily record of trout eggs taken at the McCloud River Station, California, during the season of 1883–'84.

Date.	No. of females.	No. of eggs.	Date.	No. of females.	No. of eggs.	Date.	No. of females.	No. of eggs.
1883.			1884.			1884.		
Dec. 28	16	12,300	Feb. 10	15	11,075	Apr. 30	4	3,000
1884.			15	13	8,500	May 2	7	4,300
Jan. 3	17	12,200	23	29	20,200	6	8	4,100
9	14	11,050	Mar. 3	3	2,000	9	12	8,000
11	20	15,100	9	21	16,300	13	10	7,000
14	10	8,500	15	8	6,000	May 20	13	10,000
17	5	3,000	23	8	4,500	22	12	9,000
19	3	2,500	29	10	7,000	24	15	12,000
24	21	16,200	Apr. 9	6	3,700	25	7	5,500
28	40	35,000	12	17	13,000	28	10	8,000
Feb. 3	24	18,100	14	13	8,100			
5	5	5,000	20	8	5,000			315,225

Distribution of trout eggs from McCloud River Station, California, during the season of 1884.

Date.	Distribution made.	No. of eggs.
Jan. 20	Mr. R. O. Sweeny, Saint Paul, Minn	12,000
25	Mr B. F. Shaw, Anamosa, Iowa	12,000
29	B. E. B. Kennedy, Omaha, Nebr	11,000
31	Col. M. McDonald, Washington, D. C	15,000
Feb. 18	......do	30,000
23	......do	18,000
Mar. 1	......do	16,000
5	......do	8,000
15	......do	20,000
29	......do	18,000
Apr. 27	Shepley Hatchery (on Narrow-Gauge Railroad, between Colfax and Grass Valley.	21,000
May 15	......do	12,000
22	......do	12,000
	Hatched and kept to be reared at station	21,200
	Hatched and turned into McCloud River	51,500
	Destroyed by storms and other causes	58,525
	Total	315,225

Table giving temperatures of air and water at noon at the McCloud River Trout-breeding Station, California, from August 13, 1883, *to April* 30, 1884.

Day of month.	Aug., 1883.		Sept., 1883.		Oct., 1883.		Nov., 1883.		Dec., 1883.		Jan., 1884.		Feb., 1884.		Mar., 1884.		Apr., 1884.	
	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1	....	....	88	60	60	58	66	52	54	48	48	48	48	48	60	49	64	51
2	....	....	90	62	68	58	64	52	54	48	50	48	48	48	60	50	68	51
3	....	....	92	62	62	58	64	52	54	48	54	48	50	48	62	50	68	51
4	....	....	94	61	60	57	66	52	55	48	54	48	48	48	54	50	68	51
5	....	....	92	60	60	56	66	52	56	48	50	48	44	48	60	51	66	52
6	....	....	96	61	60	54	60	51	50	48	48	48	44	48	50	51	68	52
7	....	....	96	62	62	54	58	51	48	48	54	48	38	47	48	51	70	52
8	....	....	98	62	66	54	56	51	58	48	54	50	46	47	58	51	70	52
9	....	....	98	61	70	54	60	51	58	48	50	49	42	46	52	51	68	52
10	....	....	85	60	75	54	62	51	60	48	50	49	28	45	52	50	....	52
11	....	....	84	59	76	55	64	52	54	48	52	49	30	44	50	50	60	52
12	....	....	84	59	76	56	70	52	56	48	52	48	32	45	54	50	50	52
13	90	60	86	59	76	56	71	52	60	48	53	48	40	45	....	50	52	52
14	82	60	83	60	80	56	70	53	64	48	54	48	40	46	....	49	52	52

Table giving temperature of air and water, &c.—Continued.

Day of month.	Aug., 1883.		Sept., 1883.		Oct., 1883.		Nov., 1883.		Dec., 1883.		Jan., 1884.		Feb., 1884.		Mar., 1884.		Apr., 1884.	
	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.	Air.	Water.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
15	80	60	88	60	80	56	74	53	66	48	56	48	42	46	....	49	60	52
16	84	60	86	58	76	54	66	52	72	48	60	49	36	46	....	....	76	52
17	92	61	85	59	60	51	62	52	68	48	50	49	36	46	62	50	78	53
18	92	62	84	60	58	54	64	52	68	48	52	49	40	47	62	50	78	53
19	96	62	92	60	56	54	60	52	66	48	54	49	48	47	70	51	80	53
20	95	62	100	60	60	54	58	51	60	48	56	50	50	48	70	51	78	53
21	94	62	100	60	60	54	60	51	50	48	58	50	55	48	66	50	68	54
22	88	61	98	60	60	54	62	51	....	47	60	50	68	48	60	49	64	54
23	82	61	96	60	58	53	58	51	48	47	62	50	72	48	48	49	60	55
24	86	60	95	60	54	53	48	50	48	47	68	50	72	48	49	48	56	55
25	83	60	88	60	52	53	46	49	48	47	68	50	72	48	48	48	60	55
26	100	60	80	59	48	52	50	49	49	48	54	50	78	48	38	48	60	55
27	98	62	82	59	44	52	56	48	50	48	48	50	76	48	38	48	60	55
28	88	64	80	59	46	52	60	48	50	48	46	50	75	48	40	49	70	55
29	90	61	80	58	52	52	60	48	40	48	46	48	73	48	45	50	70	55
30	88	63	70	58	60	52	56	48	46	48	50	48	....	....	55	50	86	55
31	86	62	....	....	64	52	....	....	48	48	50	48	....	....	64	50	....	....

X.—REPORT ON THE PROPAGATION OF PENOBSCOT SALMON IN 1884-'85.

By CHARLES G. ATKINS.

The purchase of breeding salmon began this year May 31, a little earlier than usual, and, the catch being rather light through the month of June, it extended into July, closing on the 5th day. There were purchased in all 568 salmon; 46 of them died in the boats in transit, 472 were deposited alive in the usual inclosure in Dead Brook, and 50 were given the range of Eastern River from Orland Village to Orland Falls, which was made into a great inclosure nearly 2 miles long by the erection of grated barriers.

The object of confining a portion of the fish in this large inclosure was to ascertain whether, in the first place, there would be any less mortality among them than among those confined in Dead Brook; and, in the second place, whether they could be recaptured in the autumn with equal facility and certainty. The result was not entirely decisive, but in favor of the large inclosure. Of those that were deposited in the river there were ascertained to have died during the summer 6 (= 14 per cent). Of those sent up to Dead Brook 46, as above stated, died on the way, and 66 more died during the summer, a total of 20 per cent. It is likely that some of those that died in the river escaped discovery, and, if so, the advantage of the large inclosure is less than would be inferred from the above figures. There were recaptured in the autumn 393 in Dead Brook, and 39 in the river, 83 and 78 per cent, respectively, of those deposited alive. If, however, we compare the autumn catch with the number originally dispatched to each inclosure, thus bringing those that died in the boats into the computation, we find that 76 per cent of those dispatched to Dead Brook were finally available, and 78 per cent of those dispatched to the river inclosure.

The recapture of the fish from the river was accomplished by traps of netting at either extremity of the inclosure, and about equal numbers were taken at the two points, 20 at the upper and 19 at the lower end. Under these circumstances, therefore, salmon seem to be quite as likely to descend as to ascend at the spawning season. The manipulation of the fish at the spawning season proceeded without noteworthy incident and resulted in a yield of 1,935,186 eggs as computed from the

data afforded by the record of losses during the development and of the packing and shipment of the residue. The sexes were represented in the proportions of 42 per cent males and 58 per cent females. Both sexes were of much smaller size than in 1883, but not far from the average of other years. The mean weight of 189 males was (at the spawning time) 8.79 pounds, and their mean length 31.85 inches. The gravid females, of whom 240 were measured, had an average weight of 10.72 pounds and an average length of 31.12 inches.

The loss of eggs during development amounted to 119,067, including the unimpregnated, which were calculated at 105,733. Of the good eggs, there were hatched at the station 78,000 on account of the U. S. Commission. The remainder, 1,730,000, were shipped to other points. The transfer was accomplished in January and February with the usual degree of success, as will appear from the subjoined statement.

TABLE I.—*Statement of the shipment of Penobscot salmon from Orland, Me., in* 1885.

Date of shipment.	Consignee and address.	Final destination.	Number of eggs. From share of States.	Number of eggs. From share of United States.	Number of eggs. Total.	No. of cases.	Condition on unpacking	Dead on unpacking.
Jan. 13	F. Mather, Cold Spring Harbor, N. Y.	Cold Spring Harbor, N. Y.		250,000	250,000	4	Good, first-class.	380
20	Same	......do		250,000	250,000	4	Much frost, and eggs good.	2,078
26	E. B. Hodge, Plymouth, N. H.	Plymouth, N. H.	160,000	......	160,000	2	Good	0
26	G. W. Delawder, Druid Hill Park, Baltimore.	Baltimore	......	10,000	10,000	1	Fair, a little indented on one cloth.	51
29	F. Mather, Cold Spring Harbor, N. Y.	London, England.	......	30,000	30,000	1	Good	0
Feb. 11	H. J. Fenton, Windsor, Conn.	Poquonock, Conn.	......	100,000	100,000	2	Good	27
11	E. B. Hodge, Plymouth, N. H.	Plymouth, N. H	47,000	113,000	160,000	2	Good	15
12	A. J. Darling, Enfield, Me.	Enfield, Me.	80,000	......	80,000	1	Good	4
12	D. Masterman, Weld, Me.	Weld, Me	120,000	......	120,000	2	Good	22
12	S. F. Baird, Washington, D. C.	Central Station.	......	10,000	10,000	1	First-class	10
18	E. B. Hodge, Plymouth, N. H.	Plymouth, N. H.	100,000	120,000	220,000	3	Package considerably frozen.	Very few.
18	Benjamin Lincoln, Dennysville, Me.	Dennysville, Me	40,000	......	40,000	1	Good	15
19	D. Masterman, Weld, Me.	Weld, Me	80,000	......	80,000	1	Very good	30
19	A. J. Darling, Enfield, Me.	Enfield, Me	70,000	50,000	120,000	1	Good	12
Mar. 5	Same	......do	37,000	73,000	100,000	1	Good	7

The contributors to the expenses, and the number of eggs allotted to each are as follows:

Contributor.	Amount of contribution.	Share of eggs.
United States	$2,100	1,084,000
Maine	1,000	517,000
Massachusetts	400	207,000
	3,500	1,808,000

XI.—REPORT ON THE PROPAGATION OF SCHOODIC SALMON IN 1884-'85.

By Charles G. Atkins.

The routine work of the season was accompanied by very few incidents worthy of mention. Preferring myself to remain at the Penobscot station, I put the work of the spawning season at Grand Lake Stream in the hands of Mr. H. H. Buck, who had the assistance of our foreman, Mr. Munson, and of several other experienced hands.

The nets spanning the stream were placed in position as usual about September 15, and the inclosures for the capture and retention of the fish were constructed after the former fashion during the last week in October. The fishing, which was carried on constantly between the dates of October 30 and November 22, yielded 808 female fish and 378 males, a total of 1,186. In number this was a gain of 184 fish over the catch of 1883, and there was a considerable increase in size. The average weight in 1883 was 3.2 pounds for the males and 3 pounds for the gravid females; in 1884 the males averaged 4 pounds and the gravid females 4.1 pounds. This is the highest point yet reached in the increase of size, which has been going on for a series of years.

Spawn was taken from 775 females. The gross yield was 1,820,810 eggs; an average of 2,349 eggs per fish. There were 155 females that yielded a percentage, generally inconsiderable, of visibly defective eggs. The losses of eggs during development amounted to 254,410, including 196,761 taken out after the usual concussion intended to destroy the unimpregnated. If we increase the latter figure by one-fifth the other losses, the usual mode of arriving at an estimate of the total of unimpregnated eggs, we have 208,291, or $11\frac{4}{10}$ per cent of the original stock of eggs. This is an unusual proportion.

The eggs were all deposited in the river hatchery, where, in the cold lake water, their development was slower than usual, and shipment was accordingly delayed till March, when it was accomplished in the usual manner between the 16th and 25th. The total shipments amounted to 1,169,000 eggs.

There were retained at the station and hatched according to law and custom, to keep up the stock of fish in Grand Lake, 397,400 eggs, from

which the unimpregnated had already been taken out as in the case of those shipped. The total loss during the further incubation and the rearing of the young fish till their liberation at the end of the yelk-sac period was, as shown by a careful record, but 216 eggs and 458 fish.

The parties to the enterprise this season, the amount severally contributed, and the number of eggs assigned each party were as follows:

Contributor.	Amount contributed.	Share of eggs.
United States	$1,300	608,000
Maine	500	234,000
Massachusetts	400	187,000
New Hampshire	300	140,000
	2,500	1,169,000

Further details of the work will be found in the subjoined tables.

TABLE I.—*Record of spawning operations, Grand Lake Stream, 1884.*

Date.	Remarks on fish handled.	Fish at first handling.							Females spawned.		Females with some defective eggs.	Eggs.			
		Total both sexes.	Males.	Females.					First time.	Second time.		Weight.		Number.	Lot.
				Ripe.	Unripe.	Spent.	Diseased.	Total females				Lbs.	Oz.		
1884.															
Oct. 31	Caught night of October 30-31	194	141	14	39			53	14			10	13	25,660	1
Nov. 1	Caught night of October 31-November 1	72	43	3	26			29	7		3			12,350	2
3	Respawning									18		2	9	48,850	3
	Caught night of November 1-2 and 2-3	136	59	21	54	1	1	77	21		7	19	13		
4	Respawning									18		4	3	19,001	4
	Caught November 3-4	80	36	11	33			44	11		3	6	5	86,355	5
	Previously found unripe								32		7	44	11		
5	Respawning									39		8	7	21,026	6
	Previously found unripe								33		5	21	0	87,204	7
	Caught night of November 4-5	82	26	20	34	1	1	56	20		5	12	2		
6	Respawning									52		15	3	40,813	8
	Caught night of November 5-6	236	41	68	120	2	5	195	68		19	57	8	183,495	9
	Previously found unripe								27		5	18	13		
7	Respawning									90		21	12	54,007	10
	Caught night of November 6-7	67	8	23	34	1	1	59	23		5	15	14	40,233	11
8	Respawning									25		3	14	9,031	12
	Previously found unripe								54		9	37	12	111,405	13
	Caught night of November 7-8	31	7	14	8	2		24	14		8	10	0		
10	Respawning									70		20	7	50,183	14
	Caught last two nights	50	5	29	16			45	29		8	60	6	143,784	15
	Previously found unripe								52		8				
11	Respawning									82		22	13	55,835	16
	Caught last night	30	3	23	3	1		27	23		5	16	14	60,081	17
	Previously found unripe								11		2	8	1		
12	Respawning									35		9	4	37,386	18
	Caught last night	49	1	32	15	1		48	32		4	25	2	147,176	19
	Previously found unripe								54		12	36	0		
13	Respawning									88		19	15	47,786	20
	Caught last night	43	3	28	8	2	2	40	28		6	24	12	90,256	21
	Previously found unripe								16		2	11	6		
14	Respawning									43		8	10	19,832	22
	Caught last night	20	2	10	3	3	2	18	10		1	6	6	16,326	23
15	Respawning									11		3	4	8,719	24
	Previously found unripe								77		11	53	5	178,273	25
	Caught last night	37	1	26	6	4		36	26		7	22	4		
17	Caught last two nights	21	2	17	1	1		19	17		3	14	6	36,390	26

TABLE I.—*Record of spawning operations, Grand Lake Stream*, 1884—Continued.

Date.	Remarks on fish handled.	Fish at first handling.							Females spawned.		Females with some defective eggs.	Eggs.			
		Total both sexes.	Males.	Females.					First time.	Second time.		Weight.		Number.	Lot.
				Ripe.	Unripe.	Spent.	Diseased.	Total females				*Lbs.*	*Oz.*		
1884. Nov. 17	Respawning									95		20	5	40,900	27
18	Respawning									20		5	3	5,372	28
	Previously found unripe								34		1	21	3	87,428	29
	Caught last night	21		18		3		21	18		7	15	12		
19	Respawning									49		8	6	19,675	30
	Previously found unripe								8			4	14	23,379	31
	Caught last night	9		8		1		9	8		1	6	2		
20	Respawning									21		4	2	7,410	32
	Previously found unripe								1			0	3	3,145	33
	Caught last night	1		1				1	1			0	13		
21	Caught last night	5		3	1	1		5	3		1	2	4	8,005	34
	Respawning									4					
	Previously found unripe								1			1	6		
22	Respawning									5				4,039	35
	Previously found unripe								1						
	Caught last night	2		1		1		2	1			2	0		
		1,186	378	370	401	25	72	808	775	765	155	773	3	1,820,810	......

TABLE II.—*Measurement of Schoodic salmon at Grand Lake Stream, Maine, 1884.*

Date.	Males.							Females, gravid.						
	Number weighed and measured.	Weight.			Length.			Number weighed and measured.	Weight.			Length.		
		Average.	Heaviest.	Lightest.	Average.	Longest.	Shortest.		Average.	Heaviest.	Lightest.	Average.	Longest.	Shortest.
1884.		*Pounds.*	*Pounds.*	*Pounds.*	*Inches.*	*Inches.*	*Inches.*		*Pounds.*	*Pounds.*	*Pounds.*	*Inches.*	*Inches.*	*Inches.*
Oct. 30	73	4.1	5.5	2.0	21.3	24	17.5	21	4.2	5.6	2.7	20.5	22.5	18
31	68	4.0	5.2	2.1	21.1	24	17.5	32	4.1	5 1	3.0	20.5	22.5	18.5
Nov. 1	43	4.0	5.1	2.5	21.0	23	18	29	4.2	6.0	3.0	20.5	23.5	18.5
3	59	4.0	5.9	1.9	20.6	23.5	17	74	4.1	6.2	2.0	20.5	24	16
4	36	4.1	5.6	2.7	21.3	23.5	19.5	44	4.1	6.0	2.7	20.1	23	17.5
5	26	4.1	5.4	3.1	21.5	24	19.5	53	4.2	5.9	2.7	20.4	23.5	17.5
6	41	3.8	5.2	1.6	20.7	23	16	188	4.1	5.9	2.4	20.4	23	17
7	8	3.8	4.8	3.1	20.9	22.5	19	57	3.9	5.0	2.8	20.1	22.5	18
8	7	3.8	4.7	3.1	20.9	23	20	21	4.2	5.0	3.1	20.4	22	18.5
10	5	4.3	4.7	3.5	21.9	23	20.5	45	4.1	5.9	2.4	20.4	23.5	17.5
11	3	3.8	4.2	3.0	20.8	22	19	26	4.0	5.6	2.5	19.8	22.5	17.5
12	1	5.1	5.1	5.1	23.0	23	23	47	4.3	5.6	2.9	20.0	23	18
13	3	3.8	4.4	2.5	20.5	22.5	18	36	4.1	5.5	3.0	20.3	22.5	18.5
14	2	3.4	3.6	3.2	20.2	21	19.5	13	3.9	5.0	2.1	20.0	21.5	16
15	1	3.3	3.3	3.3	20.0	20	20	32	3.9	5.5	2.2	19.9	22	17
17	2	4.3	5.0	3.5	22.2	24	20.5	18	4.1	6.0	2.6	20.6	23	18
18	....	....	....	....	....	....	....	18	4.3	5.5	2.9	20.7	22.5	19
19	....	....	....	....	....	....	....	8	3.9	5.1	3.0	20.7	23	18.5
20	....	....	....	....	....	....	....	1	4.5	4.5	4.5	22.0	22	22
21	....	....	....	....	....	....	....	4	3.9	4.4	3.3	20.6	22	19.5
22	....	....	....	....	....	....	....	1	4.3	4.3	4.3	20.5	20.5	20.5
	378	4.0	5.9	1.6	21.03	24	16	768	4.11	6.2	2.0	20.31	24	16

TABLE III.—*Statement of shipment of eggs of Schoodic salmon from Grand Lake Stream, Maine, in March, 1885.*

Date.	Consignee and address.	Final destination.	Number of eggs.			Number of cases.	Weight.	Distance transported.	Time en route.*	Condition on unpacking.	Dead on unpacking.
			Belonging to States.	Belonging to United States.	Total.						
1884.							*Lbs.*	*Miles.*	*Hours.*		
Mar. 16	E. A. Brackett, Winchester, Mass	Winchester, Mass.	90,000	....	90,000	1	218	389	49	Excellent	120
16	F. Mather, Cold Spring Harbor, Suffolk County, New York.	Cold Spring Harbor, N. Y.	....	60,000	60,000	1	169	640	92	Good	41
17	E. A. Brackett, Winchester, Mass	Winchester, Mass.	80,000	....	80,000	1	200	389	68	Excellent	80
17	E. B. Hodge, Plymouth, N. H	Plymouth, N. H	80,000	....	80,000	1	190	508	70	Good	42
17	D. Masterman, Weld, Me	Weld, Me	50,000	....	50,000	1	151	......	71	Good	12
18	E. B. Hodge, Plymouth, N. H	Plymouth, N. H	60,000	20,000	80,000	1	190	508	69	Moss slightly frozen, eggs good	30
18	H. H. Buck, Orland, Me	Orland, Me	....	20,000	20,000	1	70	162	50	Fair, about 2 per cent indented	6
18	R. E. Earll, World's Exhibition, New Orleans, La.	New Orleans, La	....	5,000	5,000	1	106	....	168	Partly frozen.†	550
18	R. O. Sweeny, Saint Paul, Minn	Saint Paul, Minn	....	50,000	50,000	1	134	1,789	168	Good	150
19	W. D. Marks, Paris, Mich	Paris, Mich	....	50,000	50,000	1	137	1,431	123	Good	......
19	James Nevin, Madison, Wis	Madison, Wis	....	50,000	50,000	1	146	1,536	108	Good	10
19	A. W. Aldrich, Anamosa, Iowa	Anamosa, Iowa	....	50,000	50,000	1	134	1,607	105	Good	40
20	M. E. O'Brien, South Bend, Nebr	South Bend, Nebr	....	20,000	20,000	1	84	1,925	145	Excellent	50
20	A. J. Darling, Enfield, Me	Enfield, Me	34,000	36,000	70,000	1	180	103	50	Good	60
23	O. A. Dennen, Kineo, Me., via Greenville.	Kineo, Me	100,000	....	100,000	2	340	232	99	Good	25
23	F. C. Hewey, Rangeley, Me	Rangeley, Me	50,000	....	50,000	1	156	300	80	Good	53
23	Myron Buttles, North Creek, Warren County, New York.	....	....	5,000	5,000	1	50	....	101	Good	......
23	G. W. Delawder, Baltimore, Md	Druid Hill Hatchery, Baltimore, Md.	....	5,000	5,000	1	50	805	95	A few indented, remainder fine	21
24	F. Mather, Cold Spring Harbor, N. Y.	Germany, 40,000; South Kensington, England, 30,000; Scotland, 20,000.	....	90,000	90,000	1	260	‡640	93	‡ Good	40
24	E. B. Hodge, Plymouth, N. H	Plymouth, N. H	....	40,000	40,000	1	135	508	70	Good	7
24	U. S. Fish Commission, Washington, D. C.	Washington, D. C	....	10,000	10,000	1	52	848	95	Excellent	......
25	E. A. Brackett, Winchester, Mass	Winchester, Mass.	17,000	25,000	42,000	1	112	389	67	Excellent	40
25	E. B. Hodge, Plymouth, N. H	Plymouth, N. H	....	30,000	30,000	1	98	508	70	Good	13

25	A. R. Fuller, Malone, N. Y.	Meacham Lake, N. Y.	....	20, 000	20, 000	1	85	583	339	§ Not good	2, 000
25	A. J. Darling, Enfield, Me	Enfield, Me	....	22, 000	22, 000	1	70	103	46	Good	10
			561, 000	603, 000	1, 169, 000						

* Includes the time elapsing between packing and unpacking.
† This lot of eggs was incased in frozen moss, and probably the frost penetrated to the eggs during the first day of transit.
‡ This refers only to the transportation to Cold Spring Harbor.
§ These eggs did not reach their destination until April 3, and were not unpacked until April 8, having thus been in the package 14 days, and subjected to unknown fluctuations of temperature.

XII.—REPORT OF OPERATIONS AT FORT WASHINGTON, MARYLAND, FOR THE PURPOSE OF COLLECTING SHAD EGGS DURING THE SEASON OF 1884.

By Lieut. William C. Babcock, U. S. N.

I have the honor to make the following report of operations conducted at Fort Washington, Maryland, under your direction, in the collection of shad eggs on the Potomac River during 1884:

The station established at Fort Washington, Maryland, for the collection of fish eggs on the Potomac, having proved a success last year, was reopened this year. The honorable Secretary of War issued a standing order granting to the U. S. Fish Commission the fishing privileges of Fort Washington, with permission to occupy any buildings there found necessary. A small frame house, 20 by 15 feet, was built near the wharf to serve as an office, and also to be used by the spawn-takers for their work, which had previously been done in a tent; it was found to be of great use for the preservation of fish eggs from the weather, and remains as a permanent improvement to the station.

The seine of last year having proved a success, arrangements were made with a gang of nine seine-haulers to fish the same seine on shares, giving the spawn taken to the U. S. Fish Commission, which furnished the outfit. In case the total catch did not reach the value of $1 per day for each man, an agreement was made that the Commission would guarantee to each such a sum. Arrangements were made with the owners of Tent Landing and Chapman's Point, Maryland, and of White House and Ferry Landing, Virginia, also with thirteen gill-net fishermen, to supply fish eggs to the Commission. Mr. Skidmore, the owner of Mockley's Point, a favorite resort for spawning fish, refused an offer of $150 from the U. S. Fish Commission for the right to take spawn on his shore; he expected $500, but, as he found himself in debt at the end of the season, he probably regrets that he did not accept this liberal offer.

The opposition of fishermen to the work of the Commission seems to be diminishing; they are now hoping that anything, even the restocking of the river, may give them more fish. The fisheries of the upper Potomac River this year have not paid expenses. I have heard of but two seine men who have made money during the season.

The force of the Commission station at Fort Washington consisted of the following: One spawn-taker in charge; 5 first-class spawn-takers (including 1 seine-captain and 1 seine-mender); 2 apprentice spawn-takers; 1 cook, and a boat's crew of 3 men furnished by the U. S. Navy.

A regular mess was organized, the men being quartered in the barracks on the hill. Steam launch No. 68, loaned by the Navy Department, was completed at a cost of $500, with the understanding that it was to be available hereafter during the fishing season on the Potomac River. A seine-boat hired for $50, six bateaux, and the necessary furniture, completed the outfit.

The force was so organized that each man had a specified duty to perform, a particular spawn-taker being designated for each shore; two of the first-class spawn-takers were detailed for the seine, one acting as captain and the other as seine-mender; in addition to their duties as such they collected the eggs from the fish taken in the seine. The seine was increased in length by 10 fathoms; afterwards a back of 15 fathoms 1-inch mesh was added, making it 125 fathoms long and 40 feet deep, 2½-inch mesh.

It is a decided advantage to the Commission to have the men quartered in one place; they are better housed, more economically fed, and are constantly under the direction and supervision of the person in charge. Being on the fishing shores only during working hours, there is little or no time for difficulty with the seine-haulers. I have yet to hear the first complaint of bad conduct on the part of the spawn-takers during the past season. A copy of the daily returns from the hatchery, showing the condition of the eggs taken the previous day, was furnished each man, so that a constant watch was kept as to the exact quality of his work.

Great numbers of shad being reported in the river early in April, on the 7th instant the station was fitted for service; on the 9th commenced hauling the seine, finding the first ripe female shad on the 11th; the first shad eggs, 45,000 in number, were taken on the 14th at a temperature of 50° F., which was too low for their successful development. The season opened with clear, pleasant weather; very high tides occurred on April 12, 13, and 28; the temperature of the water rose slowly and gradually from 48° F. on the 11th to 63 F. on the 30th, remaining between 64° and 74° F. during the entire month of May. The river was clear during the month of April, but on the 10th of May severe rains caused a freshet and current, making the fishing very bad.

The general conditions of the river this year have been more favorable than in the preceding one, but the number of fish taken in the Upper Potomac is far below the average. It seems difficult to account for this, and, until the reports of other rivers are given, no one can form an opinion. The reports from the Delaware and Hudson are much more favorable than usual, showing that some local condition, probably the low bay temperature, affected the movements of the shad and herring.

The Washington market was supplied with shad from New York towards the end of the season.

Strong northwest winds are not regarded with favor by Potomac fishermen; they prefer moderate winds from the south and east. From the meteorological report, Table I, which accompanies this, it will be seen that the winds from the northwest were generally very strong, often preventing fishing at all. After heavy rains there is frequently a current in the river; this puts a stop to gill-net fishing, and also prevents many of the seines from being hauled.

From April 9 to May 1 the steam launch made daily trips to the fishing shores as far down as Chapman's Point, collecting the fish eggs and running them to the hatchery at Washington the same night. This was found to be such a task for so small a boat that, on the 1st of May, the steamer Fish Hawk anchored off Mount Vernon, Virginia, and with her steam launch tended Chapman's and all the gillers in that neighborhood. Two of the spawn-taking force from Fort Washington were quartered on board the Fish Hawk, tending Ferry Landing and White House daily while the seines were being hauled.

The eggs collected at these two places were taken to Fort Washington, there placed on trays for transportation, and sent at once to the hatchery. Later in the season the steamer Fish Hawk shipped several lots of eggs on trays after they had been partially developed in water. This seems to be much the best plan; it is far easier to transport the eggs than the fry. Except for such fish as are to be placed in adjacent waters, ships seem ill adapted for hatching purposes. Wherever it can be done it is preferable to establish a station with a steady flow and pressure of water. It has been found better to clean the eggs in jars before transportation, if possible; shad eggs transport best just after impregnation, or about twelve hours after this, when segmentation has entirely taken place. Later on, a plan for doing this work will be submitted in detail, with the cost.

Herring were numerous about May 16, but disappeared entirely after that date. Only one lot of herring eggs (3,000,000 in number) was taken during the season, and these did not hatch out. Instructions were issued to the spawn-takers to try to collect them on straws or grass after development, but there was no opportunity for testing this. The idea was, by making the conditions as near to those of nature as possible, to prevent the eggs from collecting together in putrifying masses during the hatching.

On May 12 the Bryan's Point seine cut out; on May 15, Mockley's Point; on May 20, White House; on May 22, Tent Landing; on May 23, Ferry Landing. This was considerably earlier than last year. It was our expectation to pen the males caught at Fort Washington and use their milt in case the gillers should not find an equal proportion of each sex; but on the 27th instant, having caught nothing in the seine for several days, it was deemed advisable to cut out the seine and close

up the station for the season, having collected 19,000,000 shad eggs in all. The previous experience of the spawn-takers was shown in the handling of these eggs, the losses being much less than in former years.

PENNING SHAD.

On April 28, four shad (two males and two females) were penned in a live-box. One female died on the 29th and one was spawned on the 30th, the eggs not coming up at all. On May 2 the two males died, having lived six days in confinement. On the 3d of May two male and two female shad were put in a live-box. Two females and one male died on May 4 and one male on May 7. It was then concluded to wait until the end of the season and try to keep the males alive; but when that time came there were none of either sex. The shad taken at the fort are generally in pairs, so that there is little or no necessity for keeping them penned. The result of penning these shad leads to the same conclusion as last year: that the males can be kept for five or six days in good condition, but that the females invariably die after a few days' confinement.

Penning the male shad at the end of the season, when most of the seines have cut out, is a very good idea, and will save many million eggs in the future, the meshes of the gill-net being so large as to catch nothing but females.

The males can be transported from place to place in live-boxes, if necessary; still, a giller, if he finds a spawning female, can easily make a signal, and at any ordinary distance it can be brought to the station in the course of a half-hour; the eggs can be taken and impregnated even after an hour has elapsed.

Commenced hauling the seine on April 9, and during the month of April 1,230 shad were caught; during the month of May, 1,211 shad and 12,791 herring. The greatest catch of shad in a single day was on May 7, when 129 were taken; the greatest catch of herring, 2,800 in number, occurred on May 8. Finding the herring to be numerous at this time, a back of 13 fathoms, 1-inch mesh, was added to the seine on May 14, but the fish had gone by the time we were ready.

The catch of the seine, compared with last year, stands as follows:

1883.		1884.	
Shad	983	Shad	2,441
Herring	24,226	Herring	12,791
Shad eggs	838,000	Shad eggs	6,000,000

The 6,000,000 eggs which were taken in this small seine cost the Commission, exclusive of seine and outfit, the sum of $114.44, $63 in wages and $51.44 for hire of the seine-boat. Had these eggs been furnished at the usual rate of $20 per million, they alone would have cost the Commission $120. In addition to the above, the seine furnished an

abundance of fish for the food of the 22 men living at the fort, as well as several hundred catfish sent to the hatchery for distribution. The seine outfit cost but little, as most of the things were in store. I deem this to be an extreme test of the seine, when no other in the neighborhood could pay expenses. The experience of this year leads me to recommend a seine somewhat different from the one now in use, which was made from a bay-mackerel gill-net, and having been in use for three years is entirely worn out.

On page [7] will be found a diagram of the proposed seine; it is out of proportion in its general dimensions, as it would be very difficult to represent by a sketch the proportions of a seine 125 fathoms long and 48 feet in depth.

I also append* a chart of the Potomac River, near Fort Washington, with references to the hangs and rocks found in the seine berth. One of the smaller rocks near the wharf can easily be removed, and by the use of bell-buoys on the other hangs the seine can be hauled over them. It will be seen that in some places the water is upwards of 70 feet deep, which makes it very difficult to work over such ground. The seine can be hauled only on the ebb or on the first of the flood tide, from eight to ten hauls being made daily. With a strong flood tide many eddies and whirls are found in the channel, which often roll the seine. A shore where a haul could be made at any stage of the tide would be most useful to the Commission, as in former years it has been observed that most of the fish run in on the flats to spawn towards nightfall.

RECOMMENDATIONS FOR FUTURE WORK ON THE POTOMAC.

The seine at Fort Washington can be fished very economically by the Commission if the men are hired on shares; being a Government reservation it is particularly adapted to our use. While the catch of fish has not been great this year, the seine has done better in proportion than any other in the vicinity.

A careful examination of the seine berth leads me to recommend the following seine to be used next year (see page [7]):

One hundred and thirty-five fathoms cork line, ¾-inch manilla; lead line, 3-inch hemp rope, Russian bolt; depth of inner end, 18 feet, 150 meshes, 2½ inches; depth of outer end, 47 feet, 290 meshes, 2¼ inches. The general size of the seine will be 2¼-inch mesh, No. 12 thread twine, with a back 1-inch mesh.

The following articles are on hand, and can be made of use in the future:

On hand: 10 fathoms 1¼-inch mesh, 310 meshes, No. 9 thread; 135 fathoms 3-inch hemp (Russian bolt); 135 fathoms 3¼-inch manilla; 2½ coils 1¼-inch, 1½-inch, ¾-inch rope; 2 capstans; 232 corks; 2 seine lamps.

Required: 100 fathoms 2½-inch mesh, 290 meshes deep, No. 12 thread

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*See plate accompanying this report.

twine in lines; 15 fathoms 1-inch mesh, 200 meshes deep, No. 12 thread; 15 fathoms 2¼-inch mesh, 110 meshes deep, No. 12 thread; 10 fathoms 2½-inch mesh, 200 meshes deep, No. 12 thread; 10 fathoms 2½-inch mesh, 150 meshes deep, No. 12 thread; 400 corks 4 inches square; 1 capstan, complete; 6 mushroom anchors.

The seine stuff, corks, &c., required, will cost about $330; the capstan, $15; 6 mushroom anchors, and staff for bell-buoys, $60; total, $405.

In the purchase of rubber boots for the seine-haulers, I would recommend those of the Woonsocket, R. I., Manufacturing Company, they having been found best, and being most used by seine fishermen.

I would further recommend that a small steam boiler and pump be purchased, and that a tank be placed near so as to supply a circulation of water for twenty-four McDonald jars in the spawning-house, in order that all the eggs may be carefully cleaned in jars before being transported to the hatchery. If this is done, use can be made of the local steamers in transporting eggs, as they can be kept in good condition, packed on the trays just before the arrival of the steamer, and delivered in one hour and a half.

The Deane Steam Pump Company, of Holyoke, Mass., will furnish a boiler and pump for $280, to throw 35 gallons of water a minute; only 12 gallons a minute will be required to work the twenty-four jars. There is a tank already on hand in the Armory Building which can be used for this purpose. The feed-pipe should be carried well out into the river, and as far down as possible in order to secure water of even temperature, the surface temperature being exceedingly variable. This pump will not require the service of an expert fireman; any one of moderate intelligence can readily learn to work it so as to keep up the requisite supply of water.

It affords me great pleasure, as in a former report, to call your attention to the services of Mr. James Carswell, who has been chief spawn-taker in charge; his rare executive abilities and attention to duty contribute greatly to the success of the work. The conduct and attention to duty of all the other employés of the Commission, with one exception, have been such as to receive my unqualified commendation.

WASHINGTON, D. C., *July* 31, 1884.

PROPOSED SEINE FOR FORT WASHINGTON, MD., STATION.

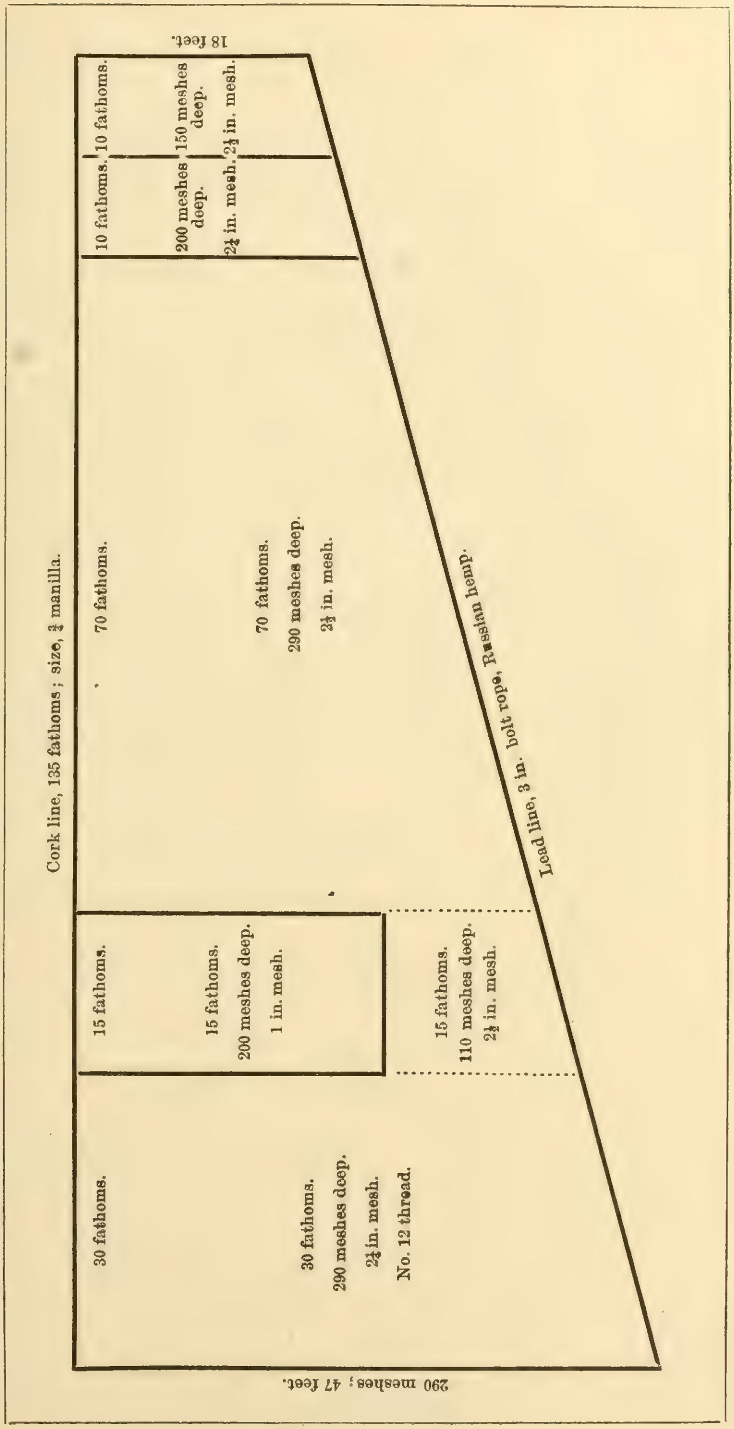
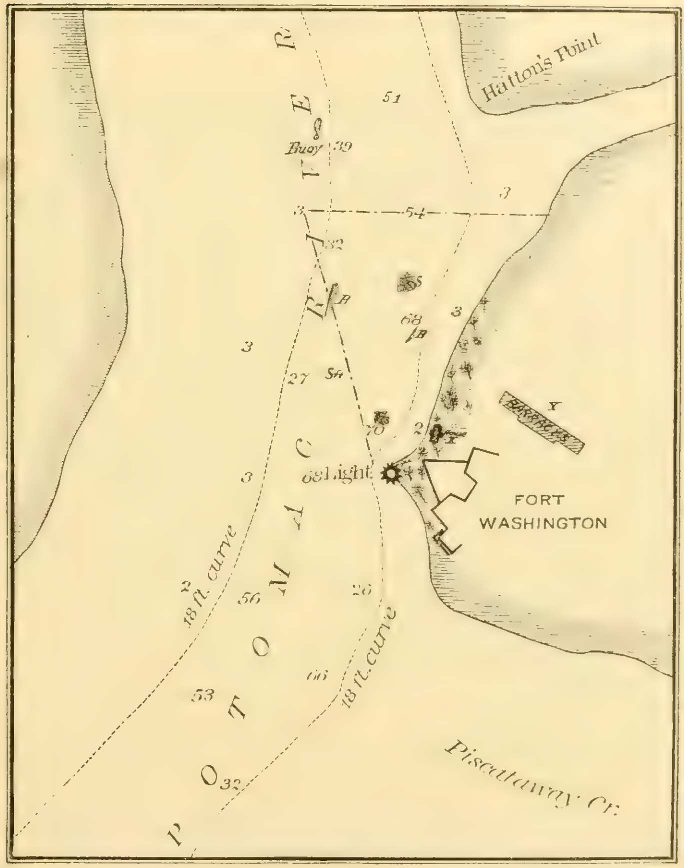


TABLE I.—*Record of meteorological observations made at Fort Washington, Md., on the Potomac River, from April 11 to May 29, 1884, by James Carswell.*

Date.	Temperature of—									Depth of water at station.	Wind.						Condition of—			
	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.		Direction.	Intensity.	Direction.	Intensity.	Direction.	Intensity.	Sky.	Sky.	Sky.	Water.
	7 a. m.	7 a. m.	7 a. m.	Noon.	Noon.	Noon.	7 p. m.	7 p. m.	7 p. m.	Ft.	7 a. m.	7 a. m.	Noon.	Noon.	7 p. m.	7 p. m.	7 a. m.	Noon.	7 p. m.	
	°	°	°	°	°	°	°	°	°											
Apr. 11	48	48	46	52	48	47½	50	48	48	40	NW.	Fresh	NW.	Light	NW.	Light	Clear	Cloudy	Cloudy	Muddy.
12	47	47	46	56	49	48	55	49	49	40		Calm		Calm		Calm	do	do	do	do.
13	49	48½	48½	50	49	48½	49	49	49½	40		do		do		do	Cloudy	do	do	do.
14	48	48	48	60	50	50	58	54	52	40		do		do	SE.	Light	do	do	do	Clearing.
15	58	50	50	64	54½	54	61½	54	54	40	SE.	Light	S.	Light	SW.	do	do	do	do	do.
16	60	52	52	69	54	53	65	54	54	40	SE.	do	S.	do	NW.	Strong	Clear	Clear	do	do.
17	56	54	52	64	54½	55	56	55	54	40	NE.	do	NW.	Strong	NW.	Light	Cloudy	do	Clear	do.
18	55	54	53	65	55	55	57	57	57	40	NW.	do	NW.	Light	NE.	do	Clear	do	do	do.
19	55	55½	55	63	58	57	62	59	58	40	NW.	do	NE.	do		Calm	do	do	do	do.
20	60	58	57	67	59	59	65	58	58	40		Calm		Calm	NW.	Light	do	do	Cloudy	do.
21	60	58	58½	63	62	61	58	59	59	40	N.	Light	N.	Light	N.	do	do	do	do	do.
22	46	56	56½	54	58	58	51	57	57	40	NE.	do	NE.	do	N.	do	do	do	do	Clear.
23	57	57	57	66½	57½	57½	53	57½	57½	40	E.	do		Calm	NW.	do	do	do	do	do.
24	54	57	57½	70	58	58	55	57	57	40	SW.	do	NW.	Light		Calm	Cloudy	Cloudy	do	do.
25*	47½	57	57½	55½	57	57	53½	57	57	40	NE.	do	NE.	do		do	do	do	do	do.
26	59	57	57	70	59	59	63½	58	58	40	NW.	Fresh	NW.	Fresh	N.	Light	Clear	Clear	Clear	do.
27	55	58	58	90	59	59	65	59	59	40		Calm	NE.	Light	SE.	do	do	do	do	do.
28	60	58	58	80	64	62½	65	61	65	40		do		Calm	SE.	do	do	do	do	do.
29	63	61	61	69	62½	62½	69	62	62	40	SW.	Light		do	SW.	do	do	do	do	do.
30	57	63	62	65	65	65	60	64	64½	40	SW.	do		do		Calm	do	do	Cloudy	do.
May 1	64½	64	64	74	65	64½	72	65	64½	40	SE.	do	SE.	Light	SE.	Light	do	do	Clear	do.
2	65¼	64½	64	80	65	65	70	65	65	40	SW.	do	SE.	do	SE.	do	do	do	do	do.
3	67	67	67	80	65	65	72	65	65	40	N.	do	SE.	do	SE.	do	do	do	do	do.
4	63	65	65	66	67	67	73	66	66	40	SE.	do	SE.	do	SE.	do	Cloudy	Cloudy	Cloudy	do.
5*	67½	67	67½	85	70	70	74	67	67	40	S.	do		Calm	S.	do	do	Clear	do	do.
6*	75	68	68	72	70	70	73	69	69	40	SE.	do	SW.	Light	SW.	do	do	Cloudy	do	do.
7*	56	66	66	57	67	67	70	68	68	40	NE.	do	NE.	do	NE.	do	do	do	do	do.
8	60	67	67	70	68	67½	69	67	67	40	NE.	do	NW.	do	NE.	do	do	do	do	do.
9	65	68	68	71	68	68	68	66	66	40	NW.	do	NW.	do	NW.	do	do	do	do	do.
10	64	65	64½	70	65	65	65	64	64	40	NW.	do	NW.	do	NW.	do	Clear	do	do	do.
11	67	66	66	71	66	66	64½	64	64	40	SW.	do	NW.	do	NW.	do	do	do	do	Muddy.
12	61	65	64½	80	69	69	65	66	66	40	NW.	do		Calm	NE.	do	do	do	do	do.
13*	68	65	64½	75	68	68	64	65	65	40	SE.	do		do	NE.	do	do	do	do	do.
14	67	64	63½	75	67	67	65	64	64	40	NW.	do	NW.	Light	NW.	do	do	do	do	do.
15	70	65	64½	80	68	68	72	67	67	40	SW.	do	SE.	do	SE.	do	do	do	do	Clear.

16	69	64	64	79	65	65	73	65	65	40	NW.	..do ...	NW.	..do ...	W.	..do ...	..do ...	Clear	..do ...	Muddy.
17	63	62	62	76	66	68	74	67	67	40	NW.	..do ..	NW.	..do ...	NW.	..do ...	..do ...	..do ...	Clear .	do.
18	62	64	63	78	68	68	65	64	63½	40	SE.	..do ...	NE.	..do ...	SW.	..do ...	..do ...	..do ...	..do ...	do.
19	62	64	63½	80	69	68½	65	64	64	40	NE.	..do ...	S.	..do ...	S.	..do ...	..do ...	..do ...	..do ...	do.
20	72	68	67½	80	70	70	69	67	66½	40	SW.	..do ...	SW.	..do ...	S.	..do ...	..do ...	..do ...	..do ...	do.
21	68	65	64½	82	70	70	69	67	67	40	SW.	..do ...	SW.	..do ...	SW.	..do ...	..do ...	..do ...	..do ...	Clear.
22	80	71	71	84	74	73	78	72	72	40	SW.	..do ...	S.	..do ...	S.	..do ...	..do ...	..do ...	..do ...	do.
23*	78	72	71	86	74	74	78	72	73	40	S.	..do ...	SW.	..do ...	SW.	..do ...	..do ...	..do ...	..do ...	do.
24	80	73	73	80	74	74	80	74	74	40	SW.	..do ...	S.	..do ...	SE.	..do ...	..do ...	..do ...	Cloudy	do.
25*	69	74	73	78	74	74	68	73	74	40	N.	..do ...	NW.	..do ...	NE.	..do ...	Cloudy	Cloudy	..do ...	do.
26	70	73	74	76	73	73	67	73	73	40	NE.	..do ...	NE.	..do ...	N.	Fresh .	..do ...	..do ...	..do ...	do.
27*	65	73	74	68	72	73	65	71	71	40	N.	Fresh .	NW.	Fresh .	N.	..do ...	..do ...	..do ...	..do ...	do.
28	55	70	70	70	69	68	66	68	69	40	NW.	Light .	NW.	Light .	NW.	Light .	Clear .	Clear .	Clear .	do.
29	60	67	68	65	68	68	66	68	68	40	NW.	Fresh .	NW.	Fresh .	NW.	Fresh .	..do ...	..do ...	..do ...	do.

* Rain.



— —. Seine berth.
B. Ore bank.
S. Stone bed.
X. House for spawn-takers.
Y. Barracks.

CHART OF POTOMAC RIVER NEAR FORT WASHINGTON.

XIII.—REPORT OF OPERATIONS AT THE BATTERY ISLAND SHAD-HATCHING STATION, HAVRE DE GRACE, MD., DURING THE SEASON OF 1884.

By William Hamlen.

In obedience to instructions received from T. B. Ferguson, I proceeded to Battery Station, at which point I arrived on March 25, 1884. My duties were to assume charge of the general work of the station, superintend the procuring of shad eggs, the hatching operations, the disposition of shad, &c.

The station had been left in a very disordered condition from last season's operations, and I at once saw that the first work to be done was to put the post in some order. I accordingly put my small force of spawntakers to work removing old logs and rubbish to out-of-the-way places.

About the most important work that was found to be done at this time was the putting of the apron in such condition as to admit of the landing of the seine without loss of fish. An examination was therefore made of the same and the mud-sill of the apron was found to be at least eighteen inches from the bottom. In putting up the apron a serious mistake was made in not driving piles into the mud at the edge of the same and bolting the same to them. However, I concluded that good-sized gravel would be the best article with which to weight the apron down, and I set my force to work getting some. For this purpose I was compelled to send our large scow in tow of a steam launch to neighboring shores, and in this manner some 1,200 bushels of gravel were procured and spread along the edge of the apron, which very effectually forced the sill into the mud, and brought the sill on a level with the bottom.

The want of a suitable boat for carrying the seine was badly felt at this time and several attempts to purchase one were made, without success. Finally, one was discovered at Georgetown, Md., and purchased at once. Launch No. 82 was sent after it, and brought it safely to the station. After some slight repairs, the boat was in first class condition for service.

In the meantime, a force under the direction of John D. Bartol had been engaged in rigging the seine, which was proposed to be 1,400 fathoms in length, in two sections of 700 fathoms each. Efforts had been

made previous to my arrival to remove all obstructions from the hauls around the island, in order that nothing should interfere with the hauling of the seine when the run of shad was on. The rigging of the seine was completed by April 10, and the first haul of the season was made in the morning of the 11th with one section. Very little was captured in this haul. In the next two or three hauls the seine was badly torn by obstructions in the river bed. This proved conclusively that the hauls had not been thoroughly cleared, so search was made for said obstructions. The fishing of the seine had passed into the hands of Messrs. Benjamin R. Sheriff & Co. on April 14, and the assistance of his gang was procured in raising the obstructions.

About this time the gillers had commenced to fish their nets, and reports were received that they were catching large quantities of ripe fish. However, owing to the fact that my force was so small and that I had no boats in which to send the men out, it was impossible for me to visit the gillers and procure the eggs. I made requisition for two boats and also suggested to put on a larger force of spawntakers, which would have placed me in a position to secure an unlimited supply of eggs. I would earnestly recommend that next season a sufficient force be put on and a sufficient number of boats procured to remedy this evil. I would suggest that six boats and twelve spawntakers would be all that is required to meet the wants of this station in this direction.

I made it a point to inquire about the number of gillers that fished in our haul or immediate vicinity. Of twenty five, eight are known to have captured an aggregate of 8,000 shad, and it is safe to presume that the others were as fortunate, and had boats and men been available the season's work would have infinitely exceeded the present result.

The season was very backward on account of northwest and northeast winds, and the shad taken in the daily hauls of the seine were generally hard. I was placed at considerable disadvantage this season by the manner in which the seine was handled. There seemed to be great difficulty in selecting suitable men for this work and the gang was changed three times, causing a loss of several days. It is my opinion that if the seine had been hauled regularly and without losing any tides, the catch of fish and eggs would have been immeasurably increased. It was very unfortunate that these changes took place just at a period when there was a large run of shad on and quantities of ripe fish.

On April 18 the first eggs were secured, 1,000 in number, from a partly ripe shad. As the hatching house was not then in condition to receive them, I placed the number in an ordinary tide-box and set it in the pool. The jars in the hatching house were placed in position on April 24, and the eggs taken throughout the rest of the season were transferred to same. The eggs placed in the pool did not hatch out very well, as the water was rather cold.

The catches generally had been quite small, but on the night of April

27 an immense number of herring were brought in by the seine. In fact, the catch of herring had been extremely large all throughout this section, but they were quite small.

For the convenience of Mr. Sheriff in salting and packing his fish, the pile-driver was removed from the old scow and a shed built on the same in which the packing was done. The seine gang occupied quarters in the old machinery barge, in which bunks had been put up for their comfort.

Finding that the supply of water for the hatching house was inadequate another large tank was ordered, and was placed in the tank tower built by Mr. Woodrow for this purpose. This was also connected with the jars and plenty of water obtained.

The first eggs from the gillers were received on April 30, after which nightly trips were made to them by our spawntakers. By this time, however, the heavy run of shad was over, and what few were caught were hard, so that few eggs could be obtained. The same system of procuring ripe shad from the gillers by purchase was in vogue this year as in previous seasons. The gillers, as a rule, were very obliging and endeavored to assist us in getting eggs as much as was in their power.

The force of men working the seine at this time manifested considerable dissatisfaction and finally refused to work, so on May 3 they were discharged, and Mr. Sheriff proceeded to Baltimore to get another gang, causing a delay in the work of several days, which seriously interfered with our work of propagation. However, before being discharged, they made a haul and it was turned into the pool in order that the experiments of previous seasons might be repeated. A force of colored laborers was put to work on May 6, and no more trouble was experienced during the remainder of the season.

Additional hauls were placed into the pool, and the fish allowed to remain undisturbed for a few days. The pool has been divided into four sections in order to make the capture of the fish easier and to separate the males and females as much as possible. On May 14 the hauling of the pool was commenced in order to see whether the shad had ripened. All the hard males and females were turned back and those spent, rotten, ripe, or bruised, were removed and handed over to Mr. Sheriff. Although several lots of eggs were examined, none ever proved good, and I am of the opinion that none will be obtained in this manner, as the shad fret themselves on account of the confinement, and are also severely bruised in their efforts to escape. I have observed very frequently that the eggs would be in knots, after their being confined for several weeks. I would also state that I think the pool an excellent place to keep male shad, but experience has shown that females do not fare well in it. I would suggest that a 16-foot scow be made for the seine used in the pool and that said scow be left in it altogether, ready at a moment's notice to capture the males for use on the females obtained from the seine or from gillers.

About the 1st of May, the eggs in the hatching house were hatching out freely, and deposits of young shad were made at intervals in the waters about the station. Shipments were also turned over to Mr. Newton Simmons for deposit elsewhere. Accompanying this report will be found tables showing in detail the hatching operations and distribution of young fish for the season.

On May 6, I received instructions to prepare one of the tables in the hatching house for the use of the Maryland Fish Commission, our facilities having been offered them and accepted. Accordingly, I made requisition for everything necessary to put the table in complete order, but the Maryland Commissioners did not avail themselves of the offer during the entire season.

Efforts were made to keep the catfish captured in the seine for distribution, but it was found impracticable, as they died very rapidly. They were accordingly turned over to Mr. Sheriff to be sold.

The water used in hatching out the eggs had been usually procured from the pool, but on May 23, the suction was changed to the artesian well. This soon reduced the temperature of the water from 76° to 59° which, I regret to report, proved most fatal to the eggs and fish on hand. The loss sustained was over 470,000 eggs and 76,000 fish, proving very conclusively that the well-water was entirely unfit for hatching purposes. The loss of the catfish is also attributable to this water.

Toward the latter part of May the catch of shad was so small that it was deemed advisable to stop hauling. Accordingly the last haul was made by Mr. Sheriff's gang early in the morning of May 31, and that afternoon the barge which had been occupied by them as quarters was taken in tow by the steamer Lancaster, and with the men aboard, carried to Baltimore, where the gang was discharged and the barge laid up for repairs. The regular force left on the Island will be engaged on other work, and before the season finally closes, the station will be put in thorough order for next season's operations.

HAVRE DE GRACE, MD., *June* 1, 1884.

TABLE I.—*Record of temperature observations made at Battery Station, on the Susquehanna River, from April 6, 1884, to June 9, 1884, by William Hamlen.*

Date.	Temperature of— Air, 7 a. m.	Surface water, 7 a. m.	Air, 12 m.	Surface water, 12 m.	Air, 6 p. m.	Surface water, 6 p. m.	Wind. Direction.	Intensity.	Direction.	Intensity.	Direction.	Intensity.	Condition of— Sky.	Sky.	Sky.	Water.	State of— Tide.	Tide.	Tide.
April 6	40	46	45	46	47	46	NW.	Strong	NW.	Strong	NW.	Strong	Clear	Clear	Clear	Clear	Ebb	Slack	Flood.
7	39	41	51	41	49	41	NW.	Fresh	NW.	Fresh	NW.	Fresh	do	do	do	do	Flood	Ebb	Do.
8	45	45	48	45	46	45	SE.	Gentle	NE.	Gentle	E.	Brisk	Cloudy	Cloudy	Rainy	do	do	Slack	Do.
9	36	43	34	43	35	43	W.	Fresh	NW.	Strong	NW.	Strong	Snow	Snow	Snow	do	Slack	Ebb	Do.
10	46	45	48	46	47	46	NW.	do	NW.	Gentle	NW.	Gentle	Clear	Clear	Clear	do	Ebb	Slack	Do.
11	46	44	48	45	46	45	NW.	Strong	NW.	Mild	NW.	do	do	do	do	do	Flood	do	Ebb.
12	48	46	52	47	56	46	NW.	Gentle	W.	do	NW.	Mild	do	do	do	do	do	Ebb	Flood.
13	50	47	56	47	55	47	SW.	do	SW.	Gentle	SE.	do	Cloudy	Cloudy	do	do	do	do	Ebb.
14	52	49	56	50	54	50	NE.	Mild	SW.	Mild	SE.	Gentle	Dense fog	Clear	do	do	Ebb	Slack	Do.
15	48	50	54	50	53	50	SE.	Brisk	SE.	Brisk	SW.	do	Rain	Cloudy	Rain	Rainy	Flood	Ebb	Flood.
16	53	51	68	52	63	53	S.	Gentle	S.	Gentle	NW.	Mild	Clear	Clear	Clear	do	do	do	Do.
17	52	50	56	50	52	50	NW.	do	NW.	do	NW.	Gentle	Cloudy	Cloudy	Cloudy	Clear	Ebb	Flood	Ebb.
18	54	53	58	54	56	53	NW.	do	NW.	do	NW.	Brisk	Clear	Clear	Clear	do	do	do	Slack.
19	56	51	64	55	62	54	NW.	Calm	NW.	do	NW.	Gentle	do	do	do	do	do	do	Ebb.
20	58	54	66	55	65	55	NW.	Mild	NW.	Mild	NW.	do	Cloudy	Cloudy	do	do	Flood	Ebb	Flood.
21	55	52	57	55	54	56	NW.	Brisk	N.	Brisk	NE.	Strong	Clear	Clear	do	do	Ebb	Flood	Ebb.
22	42	50	53	52	51	56	NE.	Strong	NE.	Strong	SE.	Mild	do	Cloudy	Cloudy	do	do	Ebb	Flood.
23	56	54	59	55	57	55	SE.	Mild	SE.	Mild	S.	do	Cloudy	do	do	do	Flood	do	Do.
24	56	54	64	56	54	56	SE.	do	SE.	Calm	SE.	Strong	do	Clear	do	do	do	do	Do.
25	52	56	54	55	54	56	SE.	do	NW.	Mild	SW.	Mild	Slight rain	Cloudy	Slight rain	do	do	do	Do.
26	56	54	66	56	60	56	NW.	Brisk	NW.	Strong	NE.	Brisk	Clear	Clear	Clear	do	Ebb	do	Do.
27	62	56	68	58	62	60	NE.	Calm	SE.	Mild	SE.	Strong	do	do	do	do	do	do	Do.
28	58	58	70	59	62	60	SE.	Mild	SE.	do	SE.	Mild	do	do	do	do	Flood	do	Do.
29	61	59	68	60	67	61	SW.	do	NW.	Strong	NW.	Strong	do	do	do	do	do	do	Do.
30	62	59	64	60	63	60	NW.	Calm	SW.	Mild	NW.	Mild	do	do	do	do	do	do	Ebb.
May 1	63	60	68	61	64	61	SE.	Brisk	SE.	Brisk	NW.	Strong	do	do	do	do	do	do	Flood.
2	67	63	74	65	72	66	SW.	Mild	SW.	Gale	SW.	Moderate	do	do	do	do	Ebb	Flood	Ebb.
3	64	64	66	65	65	66	SE.	do	SE.	Mild	S.	Mild	do	do	do	do	do	do	Do.
4	64	64	60	63	60	62	SE.	do	SE.	do	SE.	do	Cloudy	Rain	Cloudy	do	do	do	Flood.
5	62	63	75	65	73	66	Calm.	do	Calm.	do	Calm.	do	do	Clear	Clear	do	do	do	Ebb.
6	64	65	69	66	69	66	NW.	do	NW.	do	E.	Brisk	Rain	Rain	Rain	do	do	do	Do.
7	64	62	54	62	50	60	NE.	Brisk	NE.	Brisk	E.	do	Cloudy	Cloudy	do	do	do	do	Flood.
8	59	59	62	59	58	60	NE.	Mild	Calm.	Calm	SE.	Mild	do	Clear	Cloudy	do	do	Ebb	Do.
9	59	60	66	62	60	62	SW.	do	S.	Mild	S.	do	do	do	Clear	do	do	do	Do.
10	68	60	68	60	65	60	W.	do	W.	Brisk	W.	do	Clear	do	do	do	Flood	do	Ebb.
11	64	60	70	60	65	61	W.	do	NW.	do	NW.	Brisk	Cloudy	do	do	do	do	do	Do.
12	60	58	70	60	64	62	NW.	do	W.	Mild	SW.	Mild	Clear	do	do	do	do	do	Do.
13	70	60	70	60	65	60	Calm.	Calm	SE.	do	SE.	do	do	do	Cloudy	do	do	do	Do.
14	62	60	65	61	66	62	NW.	Brisk	NW.	Brisk	W.	do	Cloudy	Cloudy	Clear	do	do	do	Do.

TABLE 1.—*Record of temperature observations made at Battery Station, on the Susquehanna River, &c.*—Continued.

Date.	Temperature of—						Wind.						Condition of—				State of—		
	Air, 7 a. m.	Surface water, 7 a. m.	Air, 12 m.	Surface water, 12 m.	Air, 6 p. m.	Surface water, 6 p. m.	Direction.	Intensity.	Direction.	Intensity.	Direction.	Intensity.	Sky.	Sky.	Sky.	Water.	Tide.	Tide.	Tide.
May 15	64	62	67	62	66	64	SW.	Mild	S.	Brisk	S.	Brisk	Clear	Clear	Clear	Muddy	Flood	Flood	Ebb.
16	62	62	62	62	62	63	SW.	..do	NW.	..do	W.	..do	Cloudy	..do	..do	..do	..do	..do	Do.
17	66	60	68	60	66	63	NW.	Brisk	NW.	..do	NW.	..do	Clear	..do	..do	..do	Ebb	..do	Do.
18	64	63	74	63	68	64	S.	Mild	S.	Mild	SW.	Mild	..do	..do	..do	..do	..do	..do	Do.
19	68	63	74	64	70	64	S.	..do	S.	Brisk	S.	Brisk	..do	..do	..do	Clear	..do	..do	Do.
20	68	64	78	76	68	64	SW.	..do	SW.	Mild	S.	Mild	..do	Cloudy	..do	..do	..do	..do	Do.
21	69	65	74	66	70	65	NW.	..do	NW.	..do	Calm.	Calm	..do	Clear	..do	..do	..do	Ebb	Flood.
22	66	66	82	72	80	72	Calm.	Calm	SW.	..do	S.	Mild	..do	..do	..do	..do	..do	..do	Do.
23	80	70	80	70	80	72	SE.	Mild	S.	..do	S.	..do	..do	..do	..do	..do	..do	..do	Do.
24	78	70	80	75	84	76	W.	..do	W.	..do	SW.	..do	..do	..do	..do	Muddy	..do	..do	Do.
25	72	58	75	58	84	76	NW.	..do	NW.	..do	NW.	Brisk	..do	..do	..do	..do	Flood	..do	Do.
26	68	72	72	74	85	74	NE.	..do	NE.	..do	NE.	Mild	Cloudy	Cloudy	Cloudy	..do	..do	..do	Do.
27	80	72	86	72	74	72	SE.	..do	SE.	..do	S.	..do	..do	Clear	Clear	..do	..do	..do	Ebb.
28	64	71	66	70	65	69	NW.	..do	N.	Brisk	N.	Brisk	Rain	Rain	Rain	..do	..do	..do	Do.
29	46	62	52	62	61	64	NW.	..do	NW.	..do	S.	Mild	Clear	Clear	Clear	..do	..do	..do	Do.
30	48	63	59	64	65	64	NW.	..do	NW.	..do	SE.	..do	..do	..do	..do	..do	..do	..do	Do.
31	56	60	66	62	59	62	S.	Brisk	SE.	Mild	SE.	..do	..do	..do	..do	..do	Ebb	Flood	Do.
June 1	56	62	70	64	70	66	SW.	Mild	SW.	..do	SE.	..do	..do	..do	..do	..do	Flood	..do	Do.
2	58	64	70	66	72	68	SE.	..do	SE.	..do	SE.	..do	..do	..do	..do	..do	..do	Ebb	Flood.
3	62	66	74	68	78	70	NW.	..do	NE.	..do	NE.	..do	..do	..do	..do	Clear	..do	..do	Do.
4	70	70	82	72	80	74	SW.	..do	NE.	..do	NE.	..do	..do	..do	..do	..do	..do	..do	Do.
5	68	72	84	77	80	76	SE.	..do	NE.	..do	S.	..do	..do	..do	..do	..do	..do	..do	Do.
6	80	75	76	75	80	75	SE.	..do	S.	..do	S.	..do	..do	Rain	..do	..do	Ebb	..do	Do.
7	72	74	78	75	80	78	SW.	..do	NW.	..do	SW.	..do	..do	Clear	..do	..do	..do	Flood	Ebb.
8	72	76	80	76	72	75	NW.	..do	N.	..do	NW.	..do	..do	..do	..do	..do	Flood	Ebb	Flood.
9	68	74	80	76	80	76	SW.	..do	SW.	..do	NE.	..do	..do	..do	..do	..do	..do	Flood	Ebb.

Temperature of water in the well.

Date.	7 a. m.	12 m.	6 p. m.
May 27	65	61	52
28	60	60	58
29	54	56	58
30	56	58	58
31	56	60	58
June 1	58	62	63

TABLE II.—*Record of shad-hatching operations at Battery Station, on the Susquehanna River, from April 11 to June 10, 1884, by William Hamlen.*

Date.	Fish taken by— Haul-seines. Number shad.	Haul-seines. Number herring.	Haul-seines. Pounds of rock.	Gill-nets. Number shad.	Ripe fish. Males.	Ripe fish. Females.	Eggs obtained.	Eggs lost.	Fish hatched.	Fish deposited in local waters.	Fish deposited in other waters.	Remarks.
1884.												
Apr. 11	2	5	1	......	......	......	....	....	....	....	....	
15	3	100	9	......	......	......	....	....	....	....	....	
16	3	135	15	......	......	......	....	....	....	....	....	
17	1	11	10	......	......	......	....	....	....	....	....	Seine torn very badly.
18	21	102	13	......	1	*1	1,000	....	....	....	....	
19	84	600	......	......	7	5	80,000	....	....	....	....	
21	164	872	26	......	5	3	55,000	30,000	....	....	....	
22	175	944	......	......	7	3	50,000	15,000	....	....	....	
23	15	....	......	......	2	1	26,000	10,000	....	....	....	
24	85	2,400	60	......	4	3	50,000	15,000	....	....	....	
25	21	735	......	......	5	4	90,000	27,000	....	....	....	
26	65	2,500	......	......	......	......	....	....	....	....	....	
27	160	150,000	......	......	5	3	70,000	45,000	....	....	....	
28	215	27,000	......	......	4	4	85,000	10,000	....	....	....	
29	108	8,000	......	......	......	......	....	....	....	....	....	
30	84	50,800	......	8	10	15	428,500	128,500	....	....	....	
May 1	39	8,000	......	......	15	10	235,000	67,000	50,000	....	....	
2	38	13,000	......	......	5	2	46,000	6,000	45,000	....	....	
3	......	....	......	......	14	10	271,000	121,000	3 8,000	133,000	....	Fish in good condition.
4	No	haul.	......	......	16	9	222,000	117,000	55,000	....	....	Haul turned into pool.
5	No	haul.	......	13	......	......	347,000	118,000	182,000	93,000	....	Seine gang discharged; fish in good condition.
6	No	haul.	......	......	......	......	....	....	160,000	....	....	Wind very heavy from northeast; no haul of seine; no gillers out; therefore no spawn.
7	No	haul.	......	......	......	......	....	....	210,000	....	....	Wind very heavy; no spawn boats out.
8	332	27,700	......	1	5	3	43,000	13,000	100,000	514,000	....	Made flood-tide haul; caught 149 shad; ebb-tide haul, caught 8 shad; flood-tide haul, caught 163 shad; ebb-tide haul, caught 12 shad.
9	61	15,000	......	......	4	4	58,000	....	155,000	40,000	....	Made haul with large seine at 3 a.m.; caught 32 shad, no spawn; caught 24 shad evening haul, 58,000 eggs.
10	31	10,000	......	1	14	10	303,000	63,000	90,000	50,000	....	First haul turned into pool; 200,000 eggs from seine at station.

*Partly ripe.

TABLE II.—*Record of shad-hatching operations at Battery Station, on the Susquehanna River, &c.*—Continued.

Date.	Fish taken by— Haul-seines. Number shad.	Haul-seines. Number herring.	Haul-seines. Pounds of rock.	Gill-nets. Number shad.	Ripe fish. Males.	Ripe fish. Females.	Eggs obtained.	Eggs lost.	Fish hatched.	Fish deposited in local waters.	Fish deposited in other waters.	Remarks.
1884. May 11	No	haul.							157,000	40,000		Sunday; wind blew briskly all day; no gillers out; no eggs taken.
12	81	45,000		8	12	10	375,000	63,000		122,000	250,000	First haul turned into pool; second and third, ditto; fourth haul caught 81 shad, 8 barrels herring.
13	52	2,500		1	13	10	258,000	29,000	57,000			Took from shad caught in seine 205,000 eggs; caught 50 shad; about 2,500 herring.
14	34	5,200		10	1	1	223,000	74,000	30,000			Tide very low; water cool; fish hatching out slowly; took 50,000 eggs from seine.
15	10	600		1	3	2	120,000	10,000	70,000			Made haul with large seine; landed in pool; seine landed at 12 with 10 shad and 250,000 eggs; about 40,000 eggs from pool.
16	19	600			6	4	80,000	4,000	100,000			Seine torn very badly last night; no haul made this morning; took 80,000 eggs from seine.
17	17	600		1	2	2	83,000	11,000	70,000			Took 38,000 eggs from seine.
18							45,000	19,000	312,000	60,000		
19	63								151,000	100,000		
20	26			1			25,000	25,000	120,000	380,000		
21	55			1	3	2	70,000	70,000	114,000		250,000	Turned over to Simmons to put in Chester River.
22	57			3	6	5	186,000	186,000	26,000			Visitors from Washington; hauled large seine; caught 3,000 herring, 57 shad.
23	16			6			155,000				260,000	Sent to Havre de Grace to meet Fish Commission car; fish in good condition.
24	29			2	3	1	63,000					Major Ferguson arrived to-day; had alterations made in tank; put eggs from jars into cones; used well-water; water fell from 74° to 61°; killed all fish and eggs.
25												Eggs transferred from jars to cones; all died from sudden fall of temperature of water.
26	50			10	4	3	274,000					Put in cone at 10.30 p. m. 34,000 shad eggs; at same time put 244,000 in jars; water from well 64°; from pool 72°; eggs doing well.
27	28			6			116,000					Made flood-tide haul; caught 16 shad; stripped one; no good; eggs in cones fed by water from well doing finely; not so far advanced as those in jars, but in good condition; hauled pool; landed 15,000 herring, 37 shad; no eggs.

28												Eggs in cones doing well; water very cool—below 60°; eggs far behind those in jars; water in cones 58°; eggs at a stand or rather not any more advanced than this morning; in jars doing well; hauled pool; caught 2,000 herring, 25 shad.
29	4							34,000				Water in cones 54°; most of the eggs put in on 26th dead; jars ready to hatch out; at 10 a. m. water in cones from well 55°; at 12 m. water 56°; made haul in pool; took out 47 shad; no eggs; 5,000 herring.
30	4								212,000			Eggs in cones fed by water from well all dead; water very cold; eggs in jars all hatched out; fish in fine condition.
31									95,000			On hand available for shipment 307,000 young shad in good condition; barge left station for Baltimore in tow of Lancaster; no eggs on hand.
June 1												Fish in good condition; no eggs on hand.
2												Fish in good condition.
3										287,000		
4				40	6	3	65,000			20,000		Weather very warm; spawntakers went out at 7 p. m.; returned with 65,000 eggs; could have taken many more, but had no male fish.
5							25,000	10,000				Very warm; plenty ripe females but no male shad.
6												Weather very warm; eggs on hand in good condition; no eggs to-day.
7												No eggs last twenty-four hours; no gillers fishing around or near the station; fish from eggs taken 4th and 5th commencing to hatch out.
8												Steamer Lookout visited station to-day with Major Ferguson; left in afternoon, taking lot machinery, Kenly, Lynch, and Fay to Saint Jerome.
9									80,000		80,000	Deposited by Newton Simmons in Raritan River, New Jersey, at Somerville.
10												Hatching equipment disconnected and stored away; no more gillers out.
Total..	2,252	377,404	134	113	182	133	4,617,500	1,320,500	2,679,000	1,839,000	840,000	

TABLE III.—*Record of distribution of young shad made from May 3, 1884, to June 9, 1884, by William Hamlen.*

Date.	Number of fish.		State.	Place.	Stream.	Tributary of—	Transfer in charge of—
	Originally taken.	Actually planted.					
1884. May 3	133, 000	133, 000	Maryland	Havre de Grace	Susquehanna River	Chesapeake Bay	William Hamlen.
5	93, 000	93, 000	do	do	do	do	D. W. Kenly.
8	514, 000	514, 000	do	do	do	do	William Hamlen.
9	40, 000	40, 000	do	do	do	do	Do.
10	50, 000	50, 000	do	do	do	do	Do.
11	40, 000	40, 000.	do	do	do	do	Do.
13	122, 000	122, 000	do	do	do	do	Do.
13	250, 000	250, 000	Delaware	Seaford	Nanticoke River	do	Newton Simmons.
18	60, 000	60, 000	Maryland	Havre de Grace	Susquehanna River	do	William Hamlen.
19	100, 000	100, 000	do	do	do	do	Do.
20	380, 000	380, 000	do	do	do	do	Do.
21	250, 000	250, 000	do	Chestertown	Chester River		Newton Simmons.
23	260, 000	260, 000	New York		Hudson River		George H. H. Moore.
June 3	287, 000	287, 000	Maryland	Havre de Grace	Susquehanna River	Chesapeake Bay	William Hamlen.
4	20, 000	20, 000	do	do	do	do	Do.
9	80, 000	80, 000	New Jersey	Somerville	Raritan River		Newton Simmons.
Total	2, 679, 000	2, 679, 000					

XIV.—REPORT OF OPERATIONS AT SAINT JEROME STATION FOR 1884.

By W. De C. Ravenel.

Owing to ice in the Potomac River I did not get to Saint Jerome Station until the middle of February, and after staying a few days to make an examination of the place and property I returned to Washington and made a requisition for all articles that would be needed to carry on the station and for the tools to construct the ponds necessary for oyster culture. On the first of March I took permanent charge of the station and took an inventory of all property belonging thereto.

Owing to the severity of the weather I could not begin work immediately, but on the 10th of March succeeded in getting two laborers and commenced rolling away the sand bank that had been thrown on the marsh by the dredge, and built a bank at the end of the marsh to keep out the tide. On the 24th of same month I increased the force to six men and began to dig out the ponds, but I made very slow progress, for water soaked through the banks during every tide, and I had frequently to stop digging to bail out the water, thus losing a part of every day. Believing that it would expedite the work, I put down one of the flumes, so that the water that soaked through the banks would ebb with the tide, but the flumes had been left out in the weather and the doors became so badly warped that it did more harm than good. I then determined to nail down the doors, and continued to bail out the water every morning, finally completing the first pond on the 5th of April. I now increased the force to ten men, and hired a carpenter to fit the doors to the flumes, that they might assist me in digging the other ponds.

The work now progressed more rapidly, and on the 10th of May I had four ponds completed and ready to receive the oyster spawn. In June, for further experimental purposes, I dug a small pond at the head of the canal. The dimensions of the ponds are as follows:

First, 54 by 58 by 3 feet; second, 56 by 58 by 3 feet; third, 55 by 68 by 3 feet; fourth, 56 by 68 by 3 feet; fifth, 15 by 34 by 3 feet. All of them with an average depth of 3 feet at high water.

The ponds are inclosed by banks, the water from the canal being allowed to ebb and flow through the flumes, which are constructed with

automatic gates, allowing one to hold the water in the ponds or not as is desired. In digging the ponds I used the ordinary spade and shovel, and the dirt was rolled away in wheelbarrows across the canal. The average cost of the ponds was $97, but under ordinary circumstances they would cost much less, with greater facilities for bailing and a shorter distance to roll the earth.

The tools and wheelbarrows sent me were very inferior, most of them being useless after one month's use. I had the grounds around the cottage plowed and seeded with clover, but it was too late in the season and it did not grow as it should, so I plowed it up and planted the common cow-pea both for the purpose of enriching the soil and putting the land in order.

On the 25th of May Mr. George Tolbert was detailed for duty at the station to assist me in work on the oyster, and to complete the east and west rooms in the cottage, bringing with him lumber, lining, and other articles necessary to complete the work. He made examinations of oysters from the lower ponds belonging to the station, and also from the bay and creek, but found the season not advanced sufficiently to commence operations. On the 8th of June the Lookout arrived here, bringing steam launch No. 68 and crew of three men.

On the 10th of June Mr. John A. Ryder came down and stayed several days, giving me practical instruction in taking the oyster spawn and instructing me in the use of the microscope in order to mark the development of the young oyster. He examined numbers of oysters from the adjacent waters, but did not think the season sufficiently advanced to commence work on them regularly for two weeks or more, but reported everything at the station in good condition for work and suggested that I be furnished with salinometers to test the density of water in the ponds, as on that depended in a large measure the success of our experiments. About the 25th of June we commenced to take the spawn regularly, though the oysters were not in full season until the 1st of July, when we had no difficulty in getting as many ripe ones as we needed. Spawn was taken in the manner adopted and used by Mr. Ryder at Chincoteague Bay. The spawn was extracted from the glands of the oyster with a medicine dropper or pipette, and placed in a small vessel of sea water, where it remained until fertilization took place, and the oyster was in its swimming state. (This varied with the weather, taking from two to four hours as the weather was warm or cool.) When they arrived at the swimming state they were put into the ponds. The ponds were numbered 1, 2, 3, 4 and 5, and I generally put the spawn in the same pond for two consecutive days, and stocked the ponds in regular rotation, putting down fresh collectors each time. Six different kinds of collectors were used: First. Tile, slate, and shingles covered with mortar. Second. Tile and slate without mortar. Third. Oyster-shells strung on galvanized wire and suspended from stakes driven in the ponds. Fourth. Fagots tied in bundles and placed

around the edges of ponds. Fifth. Wheat straw tied in bundles and placed in the same way. Sixth. Oyster-shells strewn on bottom of ponds every day. The tile, slate, and shingles we placed in different positions, some standing upright in the water, others piled in squares and fastened together with galvanized wire, and others again placed in box-like frames of wood and laid on bottom of ponds. The mortar used for coating was composed of lime, cement, and sand. As soon as I began to put spawn in the ponds the doors to the flumes were shut down, to keep the spawn from going out and to keep out any spawn that might come in from outside sources, while sufficient water soaked through the banks to give the ponds a rise and fall of 2 or 3 inches on every tide.

Assisted by Tolbert and John Luckett I opened and took spawn from numbers of oysters every day and put it in the pond when it was sufficiently developed. I also tried the experiment in two ponds of putting in the spawn as soon as fertilization had taken place, but saw no results from it. In August, having found no young oysters, and fearing that the creosote on the flumes had affected the spawn, we tried the experiment of putting creosote in the water with the freshly taken spawn, but it had no injurious effects; however, at Major Ferguson's suggestion, I had the flume taken out of the fifth pond and continued putting in spawn. After the 10th of August the ripe oysters became very scarce and some days I would find none at all, so I put Tolbert at carpenter's work, and, assisted by John Luckett, continued taking the spawn until the end of the month, when the season being over I stopped entirely. To facilitate the examination of the collectors in the ponds I put down a system of gangways over them by driving posts in the bottom and laying planks across parallel to the bank, in which the flumes were placed and others perpendicular to those, so that it would not be necessary to muddy the water by walking about in it whenever I wished to examine the collectors. The position of the collectors with respect to these paths also determined whether they were the first, second, third, or fourth lot put down, and by reference to my journal the exact date could be obtained, as, for example, first lot was placed on the right of the parallel plank, second on the left, third on the right of the perpendicular plank, and so on indefinitely. I examined the collectors constantly, but did not find any oysters until the 25th of August, when Mr. Ryder came down again. We then found three oysters in the first pond, two on tile, one on slate, both coated with mortar, the largest being one-half inch in diameter. During the season collectors were placed in the lower pond and on an oyster bar belonging to Mr. J. W. Wrightson, but we did not get a very heavy set of spat, the largest number on any collector being five and many not having any at all. Mr. Tolbert also built two hatching troughs, fitted with filters at both ends, in which spawn was placed at the same stage of development as in the ponds. These troughs floated on the top of the water and were

put in the channel where the tide was very strong, but no results were obtained.

The experiment from which I obtained the most favorable results was that I tried in the channel of the creek. Sowing down about 40 bushels of shells, I put on them two or three bushels of oysters during the spawning season, and most of the shells have some spat on them.

By the 1st of June the water from the well in the cottage became so brackish that it was deemed necessary to make an effort to get better, so we determined to try and complete the artesian well that had been started the year previous. Lynch, with the launch's crew and two colored laborers, worked several days at the pipe, which had been sunk over 100 feet; but finding it impossible to sink it any deeper or get it up, sunk another alongside of it, to the depth of 80 feet, when it became so tightly fastened that even with two more laborers they could get no further. I had it all taken up and 2½-inch pipe put down in its place, and had sunk about 90 feet when the steamer Fish Hawk arrived, bringing ice and coal for the station, and carrying with her the machinery barge and launch and crew to Havre de Grace. While here the Fish Hawk crew hauled up and painted with copper paint the small scow and seine-boat, but the paint being put on before they were allowed to dry soon came off, and did no good. She returned from Havre de Grace on July 8, with steam launch No. 55 and crew of four men. The work on the well was now resumed, the 90 feet of 2½-inch pipe being used as a casing for the 1½-inch, and a force of four laborers being regularly employed to assist the launch's crew.

The men worked regularly, some days putting down as much as 40 feet of piping, others only 1 or 2 feet, according to the material we were boring through. On the 26th of July I found they could get the 1½-inch pipe no farther, being then down 321 feet, so I determined to sink the drill attached to the ¾-inch pipe until I struck water. On the 1st of August, having gone down 381 feet, I attached the steam-pump to the ¾-inch pipe and got good water, and in abundance, rising to within 1 or 2 feet of the surface. I then took up the 2½-inch pipe, and tried to get up the 1½-inch pipe, but failed. Finding I had a steady stream of good water, after trying it several days, I attached a hand-pump to the ¾-inch pipe, and have since had no difficulty in the supply and quality of the water. The well was sunk through layers of red clay and gravel, blue clay and sand alternating after that, and I had samples of the water sent to the Smithsonian Institution for analysis. The cost of well for outside labor was $210.

Tolbert, assisted by D. W. Kenly, who was sent down here on the 18th of July, completed the east and west rooms in the cottage. I had 10 feet added to the kitchen, to make a passage between cottage and kitchen, and a linen closet built in second story of cottage. Upon looking over the old lumber here I found there was enough to put up a stable, with the exception of the weatherboarding and a few shingles, which I got

from Washington, and according to my instructions I had a stable built 20 by 14 feet, with two stalls and storage-room for wagon. I received during the summer supplies of paints, lumber, and other articles needed, and had the barge and stable painted and the machinery and remainder of piping painted with asphaltum. I also had the boiler and two centrifugal pumps placed upon the small scow, expecting to use them for pumping out the ponds in the fall. On September 9 the launch, with her crew and D. W. Kenly, were transferred to Havre de Grace, the seine-boat being carried in tow. On the 13th of September, the work of the season being over, I obtained leave of absence and left William Sofford in charge.

I returned on the 8th of October, and had the scow put in position to pump out the ponds; but the boiler foamed so badly from the use of brackish water while digging the well that I had to give it up and send the boiler to Baltimore for repairs. I then opened the flume doors, and on low-water took up the collectors. In the first pond I found eighteen or twenty oysters on the different collectors, varying from 1½ inches to one-half inch in diameter. The shells on the bottom were examined, but nothing found. That pond had not been open since the 5th of July until the day I took up the collectors. In the other ponds I only found two or three, and they were very small, and as those ponds had been opened in the middle of September, it is possible that the spawn came in from open waters.

As regards the position of the collectors, I think they do best, judging from those used in the ponds and outside, stuck up straight in the ground, for they do not catch as much sediment as in any other position; and I found, judging from the few we had, that the spat attached just as readily to them. I thought at one time that the amount of sediment that settled on the collectors was the chief cause of failure; but after examining many objects to which oysters are attached, both in the ponds belonging to the Commission and in different places in Saint Jerome Creek, and finding fully as much sediment, I was compelled to hunt for other causes, and I believe it to have been the lack of free circulation. The ponds should be allowed to have the full rise and fall of tide; and that can be very easily done by using filters in the flumes and raising the doors, or taking them off for the time. The filter would prevent any of the spawn from escaping, and would not hinder the rise and fall of water in the ponds. I think it would be also advisable to deepen the ponds about 2 feet, so that on the lowest tide there would always be 2 or 3 feet of water. The cost of deepening the ponds would be about $50 apiece, and it ought to be done as early in the spring as the weather will permit.

I think for all experimental purposes we have a sufficient number of ponds, and if they are successful it will be easy to increase the number. It would be advisable to construct one pond lower down the channel, where the tide runs much stronger and there would be less leaching

from the high land. The cost of constructing a pond 50 by 60 feet with a depth of 4 feet at high water would be about $125, having the pumps on the scow to keep it dry while digging, and having on hand a flume that could be used there with filters as I proposed for the others.

I would recommend that the second story of cottage and kitchen be ceiled and the underpinning of cottage be made solid, for in its present condition the cottage is far from comfortable for winter quarters. The furniture in the cottage is very poor, and a great deal of it useless, either broken or worn out; there should be some disposition made of the numbers of old tools, wheelbarrows, and other articles that are good for nothing and have been reported as such in the regular property reports.

On the 16th November I received from Captain Smith of the Lookout three Coast Survey salinometers complete, but the only one that could be used here being broken a few days after, my observations were interrupted until December 24, when I received from Dr. J. H. Kidder another complete set with corrections; I then sent him the set that I had here, and continued keeping the record twice a day at different points, as instructed.

I found the labor plentiful, particularly in spring and summer. I used colored laborers in constructing the ponds and boring the well, and found them very satisfactory, and should recommend that they be employed here when unskilled labor is needed. In December I had the peas plowed in, and planted rye with the intention of sowing lawn grass in the spring.

XV.—REPORT UPON THE WATER SUPPLY OF THE FISH COMMISSION STATION AT WOOD'S HOLL, MASSACHUSETTS.

BY DR. J. H. KIDDER.

The station occupies a narrow strip of shore line, extending from the property of the Pacific Guano Company on the west to the beginning of the village of Wood's Holl on the east, and situated upon the southerly side of the tongue of land which separates the waters of Buzzard's Bay on the north from those of Great Harbor (an inlet of Vineyard Sound) upon the south. This tongue of land or isthmus, which is called by the local name of "Bar Neck," has always been badly off for fresh water, its few inhabitants getting their supply from rain water collected in cisterns and from shallow wells, with the single exception of a large spring upon nearly the highest part of the Neck, owned partly by Mr. C. E. Davis and partly by the Pacific Guano Company. This spring or well stands ordinarily at a height of about 4 feet above mean low-water mark, and has thus far sufficed for the considerable needs of the Pacific Guano Company, which draws water from it by underground pipes, and for the supply of the neighborhood in times of drought. Water from this spring, sent to me for examination at Washington in April of this year, was found to be potable and of good quality.

The analysis resulted as follows:

Water filtered before analysis:	Grains per imperial gallon.
Total solids	11
Of which chlorides (estimated as NaCl)	4.62
Loss on ignition (blackening slightly)	3.00
Not estimated (carbonates, &c.)	3.38
	11.00

By Nessler reaction:	Milligrams to the liter.
Free ammonia	0.016
Albuminoid ammonia	0.006

The sediment contains unicellular algæ, rotifers, *paramœcium*, *amœba*, and woody fiber. No evidence of impurity injurious to health.

The formation throughout this part of Cape Cod is drift, presenting no evidence of geological structure this side of "Rock" station, on the Old Colony Railroad, 32 miles to the northeast, and quite off the

cape. The narrowest part of the "Neck," which is scarcely 100 feet across, has been under water in very recent time, and is now protected against the sea by a stone breakwater.

Beyond (to the westward) of this narrowest part of the Neck and near to its own works, the Pacific Guano Company has, within a few years, sunk wells as far as 70 feet, getting only brackish water, and the inhabitants of the Neck state that their surface wells have become brackish in dry weather when sunk below the level of mean low water in the harbor. The Pacific Guano Company having given up the effort, and established its supply from the spring above mentioned at very considerable cost, no other efforts have been made toward obtaining a deep supply, so far as I know.

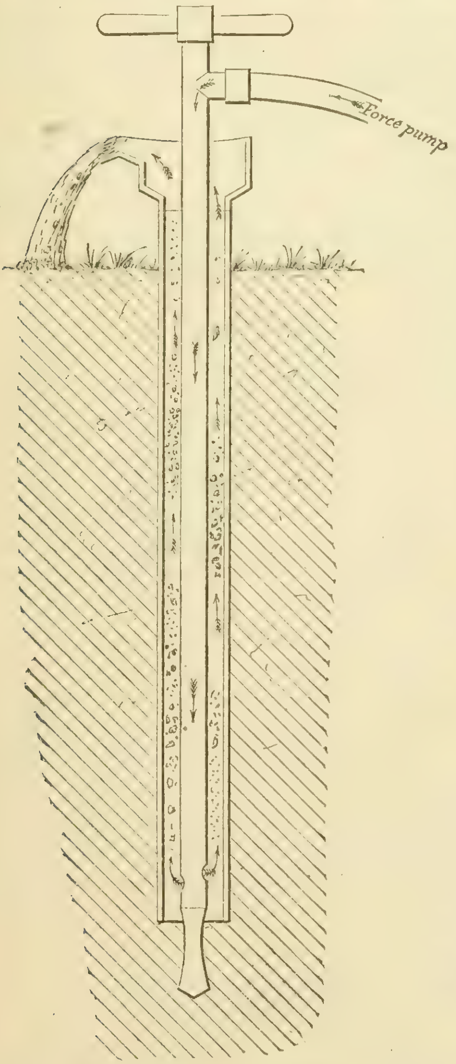
Owing, perhaps, to its almost insular position, Bar Neck has always been a dry place, most of the summer showers passing it by, either in favor of Naushon Island on the south, or of the Buzzard's Bay shore on the north; so that, considering the expense of distillation, experimental borings became, in ordinary prudence, a necessity. There being no stratified rock to be expected within a reasonable depth, a contract was made by the Commissioner with the Boston Artesian Well Company, for driven-tube wells, to be undertaken during the summer of 1884, and to be carried far enough to settle the practical question of a fresh water supply from underground.

Early in May of this year, and before the arrival of the fish commission party, I employed a well-driver from the neighboring village of Falmouth to try for water near my house. He found "stiff driving" for 2 feet at 7 feet below the surface, (on the 10-foot contour, see map A) and below that a "quicksand," extending 7 or 8 feet further, and containing a plentiful supply of water. A pump was attached and the water, which is soft and clear, but of a rather disagreeable taste, has been in use all summer, with no sign of diminution in quantity (see "A" on the map). It contained on the 20th of May 15 grains of chlorine, corresponding to 24.7 grains of salt to the imperial gallon. Below this stratum of water there appeared to be another layer of clay, and encouraged by this partial success, the Commissioner authorized me to try for water elsewhere on behalf of the Government, in the hope of finding better water below the lower bed of clay. Three attempts were made at the points marked B, C, and D, but all were unsuccessful owing to the clogging of a strainer with which the lower end of the pipe, above the driving point, was provided. Just at this time (the latter part of May) the agent and workmen of the Boston Artesian Well Company arrived, and began operations at the point marked E on the map, before the 1st day of June.

The method followed by this company differs somewhat from that of its predecessor, the well-driver from Falmouth. An ordinary 2½-inch iron pipe, without point or strainer, is driven by a heavy maul or hammer into the ground as far as it will go. A second smaller pipe, car-

rying a drill screwed to its lower end, is then passed down through the first pipe and worked by hand, being turned one way and the other, or driven down by the sledge-hammer, while a stream of water is forced through it by a pump, passing out by openings near the drill, and wash the sand, pebbles, and *débris* of broken stone up through the larger pipe.

When one length of pipe is driven nearly to the surface of the ground another is coupled to it, and so, by alternate driving, drilling, and washing, the pipe is driven to considerable depths without much trouble unless bowlders are met with, too large to be broken up by the drill. In that case the pipe is pulled up and started again in a new place.



The well E was successful at 40 feet, where a plentiful supply of water was found in fine gravel, assaying (June 1) 15 grains of chlorine (equivalent to 24.7 grains of salt) to the imperial gallon, and flowing at the rate, by hand pump, of 8 gallons per minute. This well was afterward deepened to 47 feet, to which depth the gravel continued to grow coarser, without change in the flow of water, and with a diminution in the quantity of chlorine. It was concluded, however, by the agent of the company that easier driving would be found some hundred yards or so further to the eastward, and accordingly the apparatus was moved to the point marked F on the map, and operations were resumed at that place.

Here the four wells were driven which furnish the present supply. There was some difficulty in driving, owing to the presence of underground bowlders, and the pipes were several times drawn up and started again in new places. Hence the four pipes mark the corners of an irregular quadrangle. They were finally sunk to an average depth

of 50 feet and connected together so as to enter a 4-inch main leading to the water-tower. Water from the first pipe, at a depth of 48 feet and flowing 20 gallons per minute by hand pump, contained 13.3 grains of chlorine (corresponding to 21.9 grains of salt) to the imperial gallon; rather less than the proportion shown at first by the well E. As delivered from the well it appeared to be very good water, clear and soft, and characterized only by a peculiar *flat* taste, as if insufficiently aërated.

During these last drives (F) specimens of the soil from different depths, as thrown up in the washings of the force pump, have been preserved and set up in a glass tube, so as to show the layers met with. From above downwards these are about as follows:

At 9-foot contour: From surface to 7 feet, loose sand and gravel (made land); from 7 to 9 feet, clay and fine sand (more sand than clay); from 9 to 15 feet,* fine sand and gravel, growing coarser downward; from 15 to 19 feet, clay and fine sand (more clay than sand); from 19 to 23 feet, fine sand, growing coarser downward; from 23 to 50 feet,* gravel, growing coarser downward.

At the bottom of the borings the gravel is made up of coarse pebbles, from the size of a pea to that of a hazel-nut.

There are, then, in this region two water-bearing layers; the first below a bed of clay and fine sand, and in a loose sandy soil; the second below another, stiffer, bed of clay and sand, and in very coarse gravel. This last water-bed rose in the pipes to a level of 6 feet from the surface, or 3 feet above mean low water, and, as nearly as we could decide, to just about the level of the water in the natural spring above mentioned, upon Mr. Davis's land. The agent of the Boston Artesian Well Company believes, and it seems to be probable, that this water supply comes from the hills to the north and east, and does not extend far to the westward of the wells. In confirmation of this view is the fact that several wells driven by the same company subsequently, for private parties, at various points west of the Fish Commission wells, have not resulted favorably, giving either brackish or muddy water. A well driven for the commission on July 6, however, 47 feet deep, near the shore of the harbor (G on the map) assayed (July 10) 20 grains of chlorine (corresponding to 33 grains of salt) to the imperial gallon, a rather larger quantity than that afforded by the earlier wells. Otherwise the water was similar to those previously examined.

Since the present water supply of the Commission is from wells very near salt water, and contains already a much larger proportion of salt than ordinary spring water, it is a very important problem whether the water is likely to improve or deteriorate after prolonged pumping, and whether the supply is likely to run short. To test these questions a powerful steam pump was hired in Boston, and set up at Station F, on the 10th of June. After four hours' pumping, at a rate varying from 1,500

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* Water-bearing strata.

to 3,000 gallons per hour, the supply was undiminished in quantity, the water clear and potable, excepting the *flat* taste already noted. The quantity of chlorine rose, however, from 13.3 to 24 grains per gallon, corresponding to an increase from 21.9 to 39.6 grains of salt, or nearly 100 per cent. After thirty hours' pumping, at an average rate of 1,300 gallons per hour, the amount of chlorine had increased further to 25.8 grains, corresponding to 42.6 grains of salt per gallon, the quantity of water being still unchanged. Several specimens had been sent to Washington, to the laboratory of the Geological Survey, for analysis, in the mean time, and, as the reports of these analyses, while disagreeing somewhat among themselves, showed no unwholesome or injurious ingredient, the supply was accepted, and mains were led from the wells to a water-tower near the main buildings, there to be filtered from sand and gravel in a large "sand-chamber," and pumped up into tanks for distribution to the several parts of the station.

Meanwhile the necessary apparatus and supplies had been got together for a more complete examination of the water on the spot, which was concluded on the 11th September, with the following result:

"September 11, 1884. Four liters of water were drawn from the main as it entered the tank. Pumping has been continuous, day and night, for thirty days, at an average rate of 1,000 gallons per hour, or 820,000 gallons in addition to the quantity drawn previously. There has been no diminution in the supply, and the water continues to be clear, without sediment, odorless, but characterized by a distinct, rather disagreeable, *flat* taste, thought by some observers to be 'brackish.' Reaction to litmus neutral (or perhaps very feebly alkaline).

	Grains to the imperial gallon.	Grams to the liter.
Total solids, dried at 100° C.	85	1.214
Total solids, dried at 150°–200° C.	71	1.014
Total solids, heated to redness	63	0.900

"A portion of the residue was fused, but did not blacken, at a red heat. The loss on ignition was accompanied by decrepitation, and appears not to be due to organic matter.

"Then:

	Grains to the gallon.	Grams to the liter.
Total residue not ignited	71	1.014
Of which are soluble in water	64	0.914
Insoluble in water	7	0.100
Of the soluble residue	38.65	0.552
Are chlorine; corresponding to	63.77	0.911
Sodium chloride; leaving unaccounted for	0.33	0.0047

"The insoluble residue contains calcium (as sulphate and carbonate), silica, iron, magnesia, and sulphuric acid; no copper, lead, or nitric acid. Phosphoric acid and nitrous acid not sought for. By the soap test (using Wanklyn's solution of soap and miniature gallon) hardness was estimated at 5.5 'degrees,' corresponding to 5.5 grains to the (imperial) gallon of calcium carbonate (=0.0786 gram to the liter). The fact that sulphuric acid was found in the insoluble residue and that no effervescence was noted on the addition of acids indicated a quantity of carbonic acid insufficient to neutralize all of the calcium present. On testing another sample of freshly drawn water with lime water, however, a faint precipitate resulted.

"By the Nessler test the water showed: Free ammonia scarcely perceptible, less than 0.009 part per million; 'albuminoid' ammonia 0.100 part per million.

"The 'albuminoid' ammonia appears to be due to a trace of oil, from the pipes or from the pump. This trace of oil, which experience has shown to be very persistent in iron pipes, the screw-threads of which are cut by its aid, and joints closed by an oily compound of lead, has probably something to do with the peculiar taste noted in the freshly drawn water. After filtration and the addition of ice (whereby the water is aërated) the disagreeable taste disappears.

"Microscopic examination gives only a negative result, there being no residue and no organisms of any kind."

This water, then, appears to be free from organic matter in injurious quantity, clear, without sediment, and, after filtration and aëration, potable. It contains no substance likely to be injurious to boilers and no appreciable dissolved gases. It does contain, however, a large and increasing amount of *salt*, as shown by the following observations made at different times upon the several wells which have been sunk:

	Grains to gallon.	Grams to liter.
Well A, 17 feet deep, May 16	24.00	0.343
Well E 40 feet deep, June 1	24.00	0.343
Well E, 47 feet deep, June 12*	15.50	0.221
Well F, 48 feet deep, June 3	21.90	0.313
Well F, 50 feet deep (the four wells together), June 10†	39.60	0.566
Well F, 50 feet deep (the four wells together), June 12‡	42.60	0.608
Well F, 50 feet deep (the four wells together), September 11§	63.77	0.911
Well G, 47 feet deep, July 10	32.96	0.471

* Well sunk 7 feet further and not pumped for three days.

† The four wells united, after four hours of steam pumping, 2,000 gallons per hour.

‡ After thirty hours' steam pumping, average of 1,300 gallons per hour.

§ After thirty days' continuous pumping, 820,000 gallons.

The wells from which the Commission draws its present supply started with rather less salt than their predecessors; the quantity was nearly doubled by four hours' steam pumping (about 8,000 gallons); it was increased but slightly after the withdrawal of about 40,000 gallons more; and has been increased nearly 50 per cent. by the withdrawal of rather

more than 800,000 gallons since. The well G, close to salt water, started with more salt than either of the others, but was closed and has not been since examined.

Now, this quantity of salt (64 grains in 70,000) is not sufficient to be injurious to health, and falls a little within the limit at which * (according to De Chaumont's experiments) salt becomes perceptible to the sense of taste. It is a rather significant fact, however, that the more water there is pumped the more salt it is found to contain, and the questions, whence the water comes originally, and where it gets its salt from, become of interest as relating to the probable continuance of the increase in salt hereafter, until it shall exceed the limit of potability.

Good water, similar to that in the spring already mentioned (which stands at about the same level as the water in the Fish Commission wells), is found all along the land lying to the north and east of the Eel Pond (see map), while attempts to get at the same supply by boring in the land to the westward have not thus far been successful. It seems probable, therefore, although we have no exact data bearing upon the subject, that this supply comes from the hills to the north and east of the pond, and that it is retained at or below the depth of 10 feet below mean low water by the lower of the two strata of clay above noted. A fault or break in the clay would account for the presence of the spring above noted, and the large admixture of rain and surface water which it must receive, being an excavated well of considerable extent, and situated in a depression in the land, would account for the less quantity of salt it contains.

The increase in salt, after prolonged pumping, in the Fish Commission wells, may be due to the near neighborhood of Eel Pond, which is salt water, and to the fact that long pumping from wells of this kind tends to produce a considerable cavity around the lower end of the pipe, into which water flows from neighboring parts of the soil.

There is nothing in the character of the stratum in which this water is found to account for the presence of salt, gravel being considered the best possible soil from which to draw a water supply, and there is therefore, I think, reason to apprehend that after continued pumping the proportionate quantity of salt will continue to increase.

Considering all the facts, I think that it will be judicious to pump no longer and no oftener than may be necessary for the needs of the Commission, and, when opportunity offers, to make another drive to a greater depth, in the hope of finding a still lower stratum of clay, below the level of the bottom of Eel Pond, beneath which water may be found which will be unaffected by its neighborhood.

WOOD'S HOLL, MASS., *September* 16, 1884.

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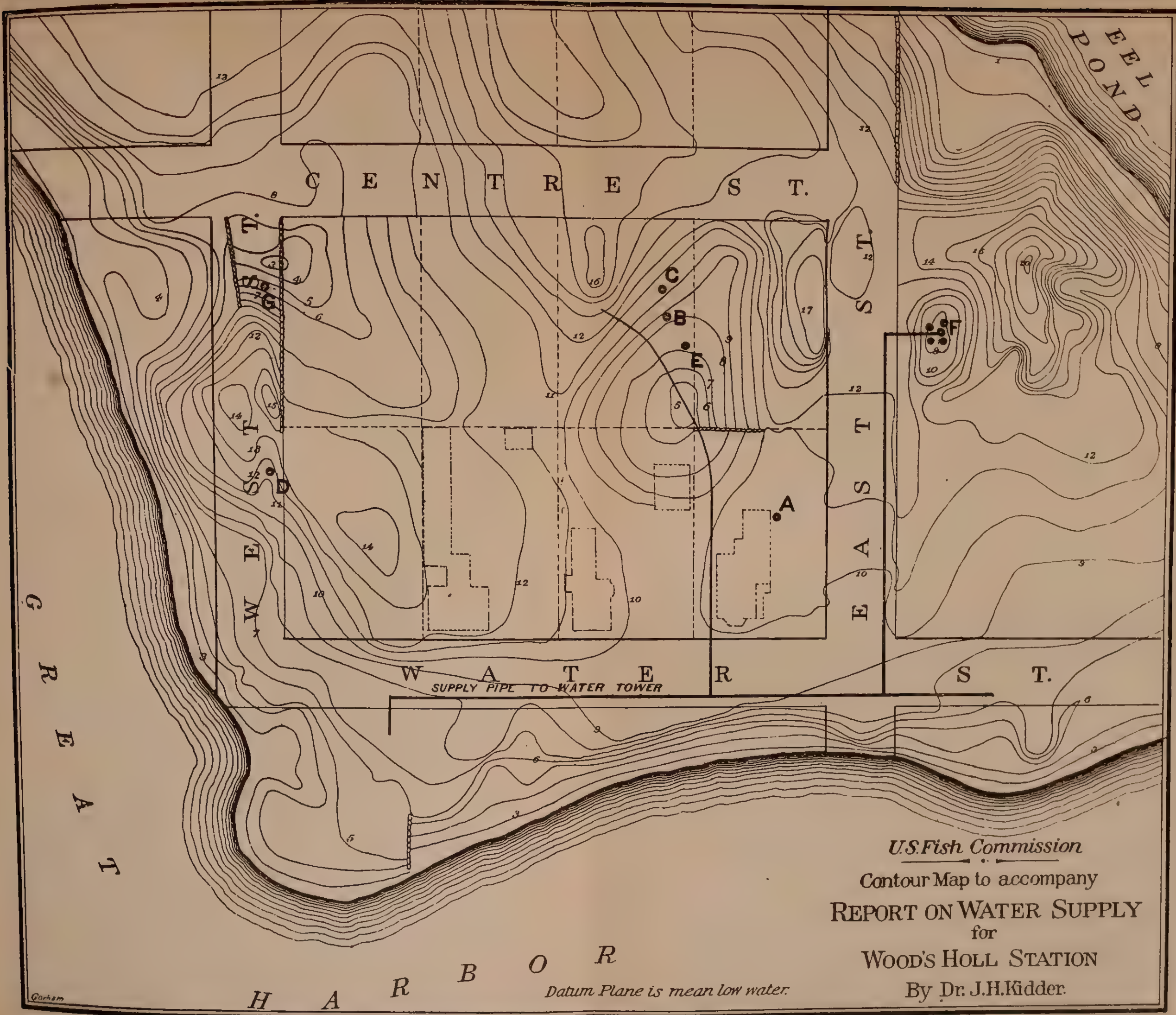
* Seventy grains to the imperial gallon.


EEL POND
CENTRE ST.
WEST ST.
EAST ST.
WATER ST.
SUPPLY PIPE TO WATER TOWER
GREAT HARBOR
A
B
C
D
E
F
G
Datum Plane is mean low water.
U.S. Fish Commission
Contour Map to accompany
REPORT ON WATER SUPPLY
for
WOOD'S HOLL STATION
By Dr. J.H.Kidder.
Gorham

APPENDIX B.

THE FISHERIES.

XVI.—REPORT UPON THE PROTECTION WHICH SHOULD BE GIVEN BY LAW TO THE FISHERIES OF THE ATLANTIC COAST.

By Marshall McDonald.

In pursuance of Senate resolution of July 26, 1882, directing "a sub-committee of the Committee on Foreign Relations, consisting of Mr. Lapham (chairman), Mr. Edmunds, Mr. Miller of California, Mr. Windom, and Mr. Morgan, in conjunction with the Commission of Fish and Fisheries, to examine into the subject of the protection to be given by law to the fish and fisheries on the Atlantic coast, as proposed in Senate bill No. 1823, first session Forty-seventh Congress," you were pleased to designate me to act as the representative of the Commission in the investigations conducted by the committee during the summer of 1883, and to direct that I should hold myself in readiness to accompany the committee and assist in the conduct of the investigation authorized.

Accordingly, in response to the request of the chairman, Mr. Lapham, I reported to him at Washington July 10, 1883, and accompanied the committee in its investigation of the coast and ocean fisheries of the Atlantic sea-board from the capes of the Delaware to Portland, Me.

Sessions of the committee were held at Cape May, Long Branch, Berkley Arms, Coney Island, New York, Boston, and Portland, Me. A voluminous mass of testimony was accumulated, which, being drawn from witnesses representing each of the interests engaged in the fisheries, necessarily presents many contradictory opinions, opposite interpretations of the same facts, and broad generalizations, based upon individual and local observations. This testimony has been printed *in extenso*, in connection with the report of the committee, as a Senate document.

At Portland the committee adjourned to meet at Old Point, Va., subject to the call of the chairman.

On October 12 the committee convened at Old Point, Va., in response to the call of the chairman, and held several sessions there and at Cherrystone, which is the center of the numerous pound-net fisheries on the eastern shore of Chesapeake Bay. An interesting session was also held at the extensive menhaden factory of Darling & Smithers, on Back River, Virginia. This point being the rendezvous of the large fleet of menhaden fishing-vessels in the employment of the factory, we

were enabled to secure very interesting details in regard to the purse-net fishing for menhaden in the Chesapeake.

The important point established by the inquiry in the Chesapeake was that the schools of menhaden entering the capes *do spawn* either in the bay itself or in the tidal estuaries tributary to it. The evidence to this effect, though circumstantial, is so full and precise as to leave little or no room for doubt, and confirms the conclusions at which I had already arrived from the study of data previously accumulated. Such being the case, the menhaden fisheries of the Chesapeake region are under like conditions and affected by the same agencies as the shore and river fisheries are, the fish being taken on their spawning grounds or intercepted and captured before reaching them.

As the necessity of legislation for the regulation of the fisheries, either by Federal or State authority, was not apparent unless it could be clearly shown that the abundance of the food-fish supply could be injuriously affected by man's agency—either directly in the prosecution of the commercial fisheries, or indirectly by impeding or hindering access of certain species to their spawning grounds—I was requested by Senator Lapham, chairman, to appear before the committee as a witness and submit for their consideration the conclusions reached by me in reference to this question.

The statements and conclusions submitted for the consideration of the committee were substantially as follows:

There are two fundamental questions involved in the inquiry prosecuted by the committee: The first relates to the possibility of the exhaustion of our salt-water as well as river fisheries by the interference of man, either directly in the prosecution of the commercial fisheries, or indirectly by the exclusion of the species from their spawning grounds. If this question is answered in the affirmative, what measures of legislation are necessary or expedient in the interest of the fisheries?

THE RIVER FISHERIES.

That man by his interference, directly or indirectly, may seriously impair or even destroy our river fisheries does not admit of question or controversy.

The most important river fishes, those which are the motive and the object of important commercial fisheries, are what are termed anadromous, and the most valuable members of this class in the Atlantic coast waters are the salmon, the white shad, the rock or striped bass, and the alewife or river herring. These all spawn in fresh water, and access to fresh water is the fundamental condition for reproduction. The young spend a portion of their lives in the streams, and then go to the ocean and remain one, two, three, or more years; there they get their development, and return to the rivers only for the purpose of reproduction. If, as in the case of the salmon, the spawning grounds

are at the head-waters of the rivers and we erect obstructions, such as dams, and thus prevent them from reaching their spawning grounds, the effect of such obstructions will be to exterminate the species in the waters thus obstructed. They will continue to come into the stream for several years; all that come in will be caught in time, and failing to reach their spawning grounds so as to maintain the species by reproduction, the river will be absolutely exhausted. We have a very marked illustration of this effect in the Connecticut River. The natural spawning grounds of the salmon are above Hadley's Falls, on the main river, and in the upper portion of the Farmington River. Before the Hadley's Falls dam and the dams on the Farmington were erected the run of salmon into the Connecticut was as important as the run of shad in that river. Salmon, indeed, were as cheap an article of food as shad in the valley of the Connecticut. The erection of the Hadley's Falls dam and of the dams on the Farmington had the effect in the first place of vastly increasing the catch of salmon at Hadley's Falls for two or three years. Then it dropped off very rapidly, and now no salmon at all enter that river.

Where, by reason of obstructions, the salmon fail to reach suitable spawning grounds, the development of the eggs goes on until they pass the period of maturity and spoil in the ovaries, the female meanwhile exhausting her energies in vain efforts to surmount the obstruction and reach suitable spawning grounds.

I have cited the case of the salmon fisheries of the Connecticut for the reason that the natural spawning grounds of this species, being entirely above the obstructions, the effect of the dams was to work absolute extermination. But what is accomplished by a dam, is or may be in a measure accomplished by exhaustive fishing. If this is pushed to such an extent in any river as to take—and it may be—all the mature salmon that enter this river, it needs but a few years to work absolute extermination. If it is not carried to this extreme, but is pushed far enough to prevent a sufficient number of the fish from reaching their spawning grounds to maintain the loss by capture or natural casualties, then the fishery will be impoverished year by year, and the depletion will go on in increasing ratio; so that, practically, although the salmon may not be exterminated, the fisheries in that river will be destroyed by being rendered unremunerative.

In the case of the shad and alewife the same result will follow overfishing. As an illustration take the Chesapeake basin, into all the tributaries of which there is each season a run of shad and herring. The fish enter these streams in February and early in March for the purpose of spawning. Successive schools of them are passing up to their spawning grounds from April on as late as July. The young fish that are spawned remain in the rivers, feeding and growing until the cool weather of the fall comes on. They then begin to drop down-stream, and by the last of November they have passed out into the bay, and

we lose sight of them until they come back full-grown and ready to spawn. As young fish in the river they are the food of the rock or striped bass, the white perch, the bass, and other species of predaceous fishes that are found in the streams. When they reach the salt waters of the bay the number of their enemies multiplies. From their birth until their return to our rivers they are preyed upon incessantly by other fish, so that the larger portion of the young fish hatched do not survive their few months' sojourn in fresh waters, and of the remnant which leaves our rivers each season after the heat of summer is over, it is probable that not one in one hundred reaches maturity and returns to the same stream to deposit its eggs and contribute to the perpetuation of its species.

Man's destructive agency in the matter, if we consider only the number captured by him, seems very trivial and insignificant in comparison with the destruction by natural causes over which he can exercise no control. Yet if by natural causes 99 per cent are destroyed before reaching their spawning grounds, man may, by continuing season after season to capture this remnant of 1 per cent, render unproductive and finally destroy the shad fisheries of a river. Even this remnant. if permitted to spawn naturally, would be sufficient to maintain production and compensate waste or casualties through natural agencies. What has been said of the shad is equally true of the alewife or river herring. Its habits are the same, its geographical range about the same, as that of the shad. In the case of either species it is very certain that present modes and apparatus of fishing, used without legal restriction, will in the end destroy or render unproductive the shad and herring fisheries in our rivers.

PROTECTIVE LEGISLATION FOR RIVER FISHERIES.

What legislation is necessary to protect our shad and herring fisheries from spoliation and utter devastation, is a question that has given rise to more discussion, awakened more angry controversy, and occasioned greater diversity of legislation than any other question connected with the fisheries.

As the fish enter our rivers only for the purpose of spawning, the shad and herring fisheries are necessarily prosecuted during the spawning season, and often immediately upon the favorite spawning grounds of the species. How, then, are we to maintain favorable conditions of reproduction without imposing too onerous restrictions upon those engaged in these commercial fisheries?

Different methods have been proposed by different State commissioners to accomplish the desired end; but as the river fisheries are under State rather than Federal jurisdiction, it is not material that they should be stated in detail in this connection.

The waters of the Potomac River lying in the District of Columbia are under the immediate jurisdiction of Congress, and the law prohibit-

ing the setting of any nets in District waters after June 1 each season will doubtless exert a beneficial influence upon the production of the river, inasmuch as the spawning grounds of shad and herring in the Potomac are largely in District waters.

It would, I think, be greatly to the advantage of our commercial fisheries, and in the interest of those who are employed in them, if the regulation and control of our inshore, river, and inland fisheries was entirely under the jurisdiction of Congress. This is especially desirable in the case of extensive sheets of water like the Chesapeake and Delaware Bays and the Great Lakes which lie within or form the boundaries of two or more States, or of rivers like the Roanoke, the Potomac, the Susquehanna, the Delaware, and the Connecticut, which traverse several States, and which, in their different reaches, are under several and usually antagonized jurisdictions. Unfortunately, under existing interpretations of the relations of State and Federal jurisdiction, it is probably not competent for Congress to enact laws regulating the details of the inshore and river fisheries. But the establishment by Congress of a Commission of Fish and Fisheries for the purpose of conducting an inquiry into the causes of the alarming decline in our sea fisheries has originated an investigation which, under the inspiration and direction of Prof. S. F. Baird, the Commissioner, has been fruitful in results of the utmost value, both to science and to the well-being of the fisheries, and may, as an indirect consequence, lead to the enactment and enforcement of necessary legislation on the part of the States.

The causes of the rapid decline in our coast and river fisheries have been so clearly demonstrated and set forth with such forceful iteration in the annual reports of the Commissioner that men have learned to know at least the conditions which unfavorably influence the fisheries; and our State legislative assemblies are at last awakened to the necessity of legislation for the purpose of regulating the fisheries, improving their condition, and protecting them from actual spoliation.

The work of artificial propagation and planting of fish in new or depleted waters has been prosecuted on the most extensive scale by the United States Fish Commission and by many of the State commissions; and while this work has not, in the face of existing unfavorable conditions, accomplished as much as it might do, it has at least had the effect of checking the rapid decline of the fisheries in progress when this means of restoration was inaugurated, and in many cases has brought about a positive and substantial improvement.

The attention of the committee is earnestly directed to the fact that we are now expending considerable sums of money annually in the propagation and distribution of fish in our waters, and at the same time in those very streams in which we are seeking to create or restore productive fisheries, the Government has erected, and year after year is continuing to erect obstructions that negative every result to be expected from the work of artificial propagation and planting. In other words,

shad and salmon—these being the principal species—are being placed in the head-waters of streams in all sections of the country in vast numbers; and the Government, through its engineer department, is engaged at the same time in erecting obstructions that render all this work of no avail, so far as those sections of country are concerned that lie above the obstructions; and these are often vast sections. Now, I am convinced that if we permit the fish to reach their spawning grounds by removing, or by providing the means to enable them to pass, the obstructions which year by year are contracting the breeding areas of the shad and the salmon, and thus restore to them the range that they had before we put obstructions in the rivers, we will accomplish as much year by year by natural means as we are now accomplishing by artificial, and it would therefore appear to be a proper suggestion for the committee to make in this connection that *whenever the plans for the improvement of the navigation of any of our rivers contemplate the erection of obstructions which will intercept the passage of fish, the engineer in charge of such improvement shall be instructed in his plans and estimates to provide for suitable fishways, to be erected in accordance with plans prescribed by the United States Commission of Fish and Fisheries.*

If the general Government will set the example by providing suitable fishways over the obstructions now erected, or to be erected, in our navigable rivers, the good results will be soon apparent. The several States will follow the example set, and the areas of production thus recovered will determine a permanent increase in the productive capacity of the river.

There is not a State in which there are not already in existence numerous dams which effectually bar the ascent of the shad and the salmon to their spawning grounds. They are erected by the Government in connection with plans for improving the navigation of our inland waters. Until effectual means are provided for the passage of fish over them, they are a standing menace to the perpetuity of our valuable river fisheries.

THE SEA FISHERIES.

In dealing with the salt-water or sea fisheries it is important to keep clearly in our minds the fact that all the great fisheries of the world are prosecuted during the breeding or spawning season of the fish—the herring fisheries everywhere, the cod fisheries, and in part the mackerel fisheries. We should also keep in view the fact that the results of extensive observations by numerous observers point to the conclusion, that the spawning grounds of the salt-water species are just as definitely localized in the ocean as are the spawning grounds of the shad and herring in our rivers.

The influence of the great ocean currents and of meteorological conditions reacting upon the temperature of the water is such as to define and circumscribe geographically areas of water in which suitable con-

ditions of temperature for the development of the eggs of different ocean species prevail during the spawning season of the species.

To these areas, thus circumscribed or defined, the oceanic species, in the season of their spawning, resort as certainly and invariably as do the shad and the salmon each in their season to our rivers; such being the fact, it is possible in the case of the sea fishes that destructive or exhaustive methods of fishing pursued on their spawning grounds, may result in the destruction or exhaustion of the schools thus localized. It is true that the amount taken by man's agency may be infinitesimal compared with the aggregate destroyed by natural causes, but man's supply is taken from the remnant which has escaped destruction by natural causes, and all or nearly all must be permitted to spawn in order to maintain production. I think, therefore, that both in regard to the ocean species and the river species, the question whether we can affect the supply by man's agency is to be answered beyond a doubt in the affirmative.

As regards the menhaden, which is the principal object of this inquiry, the investigations of the Chesapeake region, although the evidence was circumstantial, showed beyond a doubt that the menhaden on entering the Chesapeake Bay in the spring of the year entered there full of spawn; that by the middle of May this spawn had been deposited and the fish were then lean and impoverished. As to the menhaden in the Chesapeake region, though usually regarded as an ocean species, spawning broad off from the shores, the probability is, and the conviction of the fishermen is, that it spawns in that region in the tidal creeks and salt-water estuaries of the rivers, and of course it would be under the same conditions and, as far as exhaustion is concerned, affected by the same agencies as the river species.

REGULATION AND PROTECTION OF THE SEA FISHERIES BY LAW.

The propriety of any law prohibiting the prosecution of the menhaden, mackerel, cod, or herring fisheries, during the spawning season of the fish is extremely doubtful.

Legislation should be directed not so much to prohibition of fishing during the spawning season—about which we are not yet very certain—but rather to such general regulations as will contribute to maintain production and put the product into market under the most favorable conditions to the fishermen.

The result of our investigations on the coast defines very clearly not only the character of the legislation that is necessary, but indicates that such legislation will be acceptable to the fishermen themselves. The mackerel fishermen, or rather the men who handle the mackerel and control the fishermen, were found to have a very general concurrence of opinion in favor of a law prohibiting fishing for mackerel before the 20th of June each season. In the Chesapeake region it was found that the principal men engaged in the menhaden fisheries, those who had

the largest moneyed interests in it, were favorable to the enactment of a similar law regulating the menhaden fisheries. It therefore seems practicable, as well as proper, to enact such legislation as will both increase the production of these two fisheries (the mackerel and menhaden) and place the product in the market under the best conditions, both for the consumer and the fishermen. To go further than to prohibit purse-net or pound-net fishing prior to a definite date each season would be neither practicable nor expedient.

The prohibition of the use of steamers in the mackerel or menhaden fisheries does not seem to be advisable. It is in the general interest to permit the prosecution of the fisheries by methods and apparatus that will secure the most profitable returns. Moreover, if legislation is enacted, fixing a date for the beginning of the mackerel fisheries, the shortening of the season proposed will greatly diminish the advantage of steamers over sailing-vessels; for the heavy expense incurred in the maintenance of the steamers for so short a season of active operations would impose a heavy tax on them.

WASHINGTON, D. C., *June* 29, 1885

XVII.—NOTES ON THE NEW ENGLAND FISHERY FOR SWORDFISH DURING THE SEASON OF 1884.

By A. Howard Clark.

The following brief notes on the swordfish fishery were gathered during a visit to Gloucester, Mass., in September and October, 1884, and are supplementary to the paper by Mr. G. Brown Goode, entitled "Materials for a History of Swordfishes," published in the Fish Commission Report for 1880.

This industry was of unusual importance in 1884; the fish were very abundant and a large number of vessels were engaged in their capture. In previous years the fleet had not exceeded fifty sail, but this year it numbered over one hundred vessels. The catch, including those taken by the regular fleet, by mackerel and cod vessels, and by others, is estimated at 7,000 fish, equal to nearly 2,000,000 pounds weight, and valued at $60,000.

The season began on the usual grounds off Montauk Point, Long Island, on June 9, when, according to Captain Gooding, the first capture was made by the schooner Emma. On June 15 Captain Warren Ball, of boat Active, made the first capture in the vicinity of Block Island. As the fish became more plentiful the fleet increased in size until it numbered thirty sail from ports between Block Island, New London, and Wellfleet. Some of these vessels continued the fishery south of Cape Cod throughout the summer, but most of them by the latter part of July had changed their cruising grounds to the Gulf of Maine, where the fish were larger and in greater abundance than on the southern grounds. During August the northern fleet was gradually augmented by vessels from Massachusetts and Maine ports, led into this fishery by the scarcity of hake and other species, and the promise of a profitable swordfish season. At the beginning of September nearly a hundred vessels were cruising between Cape Ann and Grand Manan Bank, in the Bay of Fundy.

The best fishing grounds in August were on the inner Jeffries and from 12 to 15 miles off shore from Boon Island and Wood Island, Maine. The nearest inshore that fish were captured was within 3 to 4 miles of the coast. At some seasons many of the fleet cruise on George's Bank, but this year none of them went there except the schooner Emma Clifton. A number of swordfish were taken on George's by the regular cod fishermen, who report the fish very abundant there, particularly on the southeast part of the Bank.

Mr. Edwin A. Leavitt, of schooner Lizzie W. Hunt, of Saco, Me., states that about August 28 he was cruising 12 miles east-southeast of the Isles of Shoals and counted forty-seven swordfish vessels in sight, and he thinks that during that week these vessels captured 1,000 fish. At the same time other vessels were cruising farther to the eastward. The Lizzie W. Hunt took 82 swordfish from July 14 to September 6, and Captain Wallace of that vessel says that in his eight years' experience he never before saw them so abundant.

The farthest eastward that the fish were reported was in latitude 44° 15′, and longitude 58°, where they were seen by Capt. E. L. Jerrell, of New Bedford.

The season was at its height during the month of August and until the latter part of September, when the fish began to disappear; by October 10 they had left the coast.

Inquiry was made of more than fifty fishermen regarding the spawning habits of swordfish, and with very few exceptions there was a total ignorance on the subject. In reply to the question whether they had ever seen spawn in the fish, the usual answer was, "No, we never saw any; the fish must all be males." The opinion generally expressed by the fishermen was that very few if any female swordfish visit this coast, and that their spawning ground must be in distant waters. Capt. Horace J. Drew, of schooner Send, belonging at Plymouth, thinks that spawning fish sometimes visit this coast, for in 1883 he saw what he thought was nearly ripe spawn in a medium-sized fish; it had the appearance of cod spawn in shape, though much larger.

The most interesting statement on this subject was by Capt. William T. Gooding, of New London, Conn. He has been swordfishing for twenty-two years and has the points of three swords in the planking of his vessel. In an interview September 8 he said that about August 15, 1884, he caught a female swordfish off Monhegan, Me., that weighed about 450 pounds: "The spawn was running out. On dressing the fish I examined this spawn. It was red and about like a cod roe after spawning; in two bags about 12 inches long and 4 or 5 inches through. The eggs were about the size of small peas. I thought of saving this specimen, but being eager to get to market with my catch I forgot it, and it was thrown overboard by one of the crew."

The principal food of swordfish during the past season, south of Cape Cod, was squid and skipjack; while in the Gulf of Maine they lived chiefly on dogfish, mackerel, and herring. According to statements of fishermen, a swordfish never touches a still bait. They will break into a school of fish, then sink down, and take their prey while it is moving.

The smallest specimen reported by any of the fishermen weighed 22 pounds, fresh from the water, and was caught off Block Island early in the season. Another weighing 32 pounds, sword and all, was taken by Captain Hammond, of schooner Gracie M. Phillips. The largest one is reported by Mr. D. W. Williamson, of Wellfleet, who says, in a letter

dated October 13, 1884: "There was a swordfish ran ashore here last week, about 12 feet long, 6 feet around, and weighed 700 pounds."

Numerous specimens of pennella, encysted worms, and other swordfish parasites were collected at Gloucester during the season by Capt. S. J. Martin and sent to the National Museum for examination. The pennella were generally imbedded in the flesh of the fish, with the extremities protruding from the surface. In cutting up the fish for salting, several specimens of encysted worms were found in the solid meat. Some large specimens of swordfish suckers, or remoras (*Remoropsis brachyptera*), were also secured by Captain Martin and forwarded to the Museum.

In the capture of the swordfish the ordinary harpoons or darts were commonly employed, though some of the vessels were also supplied with harpoon-guns. These were nothing more than common shotguns, No. 10 bore, with the harpoon-head fitted to the end of a wooden rod fired from the gun. To the harpoon-head was attached a line for holding the fish when struck. Captain Swett, of schooner Alice Norwood, hailing from Biddeford, is said to have introduced this new method of capturing the fish. The lower end of the iron used with the gun is lanceolate-shaped and is connected by a central shank with two movable toggles that fold close to either side of the shank and that spread apart when the harpoon line is drawn taut. A sample of this pattern of iron has been presented to the National Museum by Mr. Leavitt, of Saco, who used it with a pole instead of with a shotgun.

This specimen is about 5 inches long, with a socket or hole in the upper end, in which the ramrod is inserted. Midway of the length of the iron is a hole for fastening the harpoon line.

The most common pattern of dart has two lanceolate blades, each about 1½ inches long and connected by a central shank, making the whole length from 4 to 5 inches. In the middle of the shank, between the blades, is a hole for attaching the harpoon line, and in the head of the shank a socket for the iron at the end of the harpoon pole.

The swordfish is struck either from the pulpit at the end of the bowsprit or from a small rowboat. Mr. Edward Leavitt states that nearly one-fourth of all the fish taken the past season were struck from boats. One vessel carried a whaleboat rigged for striking and holding the fish, but the general custom when fishing with boats was to throw overboard a half-barrel buoy attached to the harpoon line. When the weather is calm the fishermen prefer striking from a boat rather than from the vessel. The fish is then hauled alongside the vessel, killed with an ordinary whale lance, and lifted by purchase-blocks to the vessel's deck.

About midday is said to be the best time to catch these fish, especially if there has been a breeze and it dies away calm. Very few can be taken in rough water, but in calm sunshiny days in August they are to be seen in all directions on the fishing grounds, sometimes thirty or forty appearing in a few hours.

Captain Gooding says: "In regard to swordfish being in deep water, if you strike a swordfish and he goes directly down in anything over 90 fathoms, the moment he touches bottom he will be dead, and will come to the surface very easy. Whenever bottom fish are found in swordfish, and they are in deep water, I always notice that there is a shoal bank very near; and we always find better fishing close to some bank, with the deep water around it."

Many fishermen have thrilling experiences of narrow escapes from being pierced by the blades of swordfish, and some of the vessels have blades fastened in their planking. Mr. Edward Leavitt, of Saco, Me., says that during the past summer a swordfish attacked the dory in which he was seated and thrust its sword through the bottom of the dory within a few inches of himself. The captain of the schooner Ranger, of Harpswell, showed a half-barrel buoy with a blade broken off across the grain of one of the staves, without materially injuring the buoy. The New Orleans Times-Democrat publishes an account of damage done by a swordfish to the three-masted schooner Themis, of Boston, on the 5th of last August, while on a voyage from Mobile to Tampico. The vessel was found to be leaking badly, and as soon as the harbor was reached an examination showed that the blade of a swordfish had pierced "the copper sheathing of the schooner; then the outer timbers of the hull, four inches in thickness; next a vacant space of nine inches between the outer and inner timbers, or 'ceiling;' and lastly four and one-half inches more of solid wood constituting the ceiling; altogether nearly nine inches of plank and copper, with eleven inches of vacant space, including the two inches of the blade end broken off when the cause of the leak was discovered."

Concerning the pugnacity of swordfish, Captain Gooding says:

"I have caught a great many swordfish, and my vessel has the points of three swords in her planking, and it was all our own fault in getting them there. All the swordfish I ever saw struck or have struck myself, if fastened close to the head, would always act more or less crazy and run with no particular object; just as apt to run into the vessel as anywhere; sometimes keeping a taut line and at other times the line lying all in slack bights. If fastened well abreast the large fin they always run from the boat or vessel to the windward, keeping a very taut line, and when hauled close up to the vessel their struggles to keep clear of her are more rapid, never turning on the vessel to show any signs of fight.

"The accidents to vessels are very few compared with the craft that are sailing on their cruising grounds. I don't think any craft was ever pierced by swordfish intentionally. I have seen swordfish a great many times rise within a few feet of our craft when we were hove to, both night and day. They could have hit her easy enough. I have also been on the bowsprit and have seen them coming up close under the bow, but they would always turn one side if the vessel went over them;

so I think they strike a vessel more by accident. When they do get their sword fastened into a boat they hold very still and seem to be afraid they will break their sword off. I have known them several times to pierce a dory and remain perfectly still until the dory was rowed to the vessel, and as soon as liberated they would commence their struggles; but, as I said before, this always happened when fastened close to the head."

Mr. Leavitt says he never saw two or more swordfish swim in company, but has often noticed two of them approach one another from opposite directions, when they would immediately move off as if shy or afraid of each other. During the past summer he saw a piece of sword broken off in the tail of a swordfish, giving evidence of fighting.

The regular Southern New England swordfish vessel carries four men—the captain, cook, striker, and mastheader. The proceeds of the voyage, after deducting "big generals," or expenses for provisions and wharfage, are divided into four equal parts or shares. One share belongs to the vessel, one share to the captain, and one to the mastheader. The cook receives about $25 per month, his wages being paid in equal shares by the other three men. The vessels, belonging in Northern Massachusetts and Maine, "share the fourths or fifths," that is, one-fourth or one-fifth of the proceeds belongs to the vessel, and the balance is divided among the men, who share equally the expenses for provisions during the voyage.

The vessels employed were generally sloops or small schooners, ranging from fifteen to twenty-five tons, and some were of smaller size, particularly those belonging at Block Island.

Portland, Me., is the headquarters for the fishery in Eastern New England. There were landed at that port during the past season, according to John Lovitt & Co., about 1,500 swordfish, averaging 275 pounds each. Mr. O. B. Whitten, secretary of Portland Fish Exchange, estimates the number landed there at 2,000, averaging 300 pounds each, dressed for market. At Portsmouth and Newburyport about 150 swordfish were landed.

The following record of fresh swordfish landed at Gloucester during the season is furnished by Capt. Stephen J. Martin, of the United States Fish Commission:

Date.	Number of fish.	Total weight.	Date.	Number of fish.	Total weight.
Aug. 11	9	2,730	Sept. 17	4	1,260
13	1	400	18	6	1,870
14	50	15,460	19	22	9,360
21	1	330	20	7	2,200
29	24	7,420	21	5	1,560
Sept. 2	3	950	23	15	4,062
4	35	10,000	26	1	300
5	36	10,922	29	4	1,200
6	100	30,000	Oct. 2	1	588
7	40	12,694	6	7	2,150
12	42	12,780	8	1	300
13	22	6,845			
15	8	2,600	Total	444	137,981

Captain Martin states that there were also landed at various times during the season a total of 100 barrels of salted swordfish, taken principally by the mackerel catchers. At Rockport 150 fresh swordfish and 30 barrels salted swordfish were landed. Allowing one swordfish to each barrel salted, the total number represented by receipts at Cape Ann was 724, which is far in excess of the capture of any previous year of which there is any record.

At Boston the receipts were 663,167 pounds, which includes about 350,000 pounds landed there by the swordfish vessels and the quantity arriving by rail or steamer from Portland, Gloucester, and other ports.

The number landed at New Bedford is stated by Willard Nye, jr., to have been 150. A large number were landed at Newport, at Block Island, and other places in Southern New England, also at Provincetown, and ports north of Cape Cod not previously mentioned. A considerable number were consumed locally at various places along the coast. The schooner Julietta, of Harpswell, Me., was probably the "high line" of the fleet. Between July 6 and September 15 this vessel had taken 126 swordfish. The Millie Florence had captured 106 swordfish between July 15 and September 14. Captures by vessels belonging at Cape Cod and farther south, from the beginning of the season until the latter part of September, were reported as follows:

Name of vessel.	Home port.	Number of swordfish captured.	Fishing grounds east or south of Cape Cod.
Scud	Plymouth	67	East and south.
Active	Wellfleet	49	Do.
John L. Cole	do	2	
Nellie Rich	do	2	
Sarah C. Smith	do	11	
L. O. Foster	Dennis	43	Do.
Ellen R	do	13	Do.
Olive A. Lewis	do	83	Do.
Black Swan	New Bedford	51	Do.
Spy	do	60	South.
Quilp	do	45	East and south.
Emma Clifton	do	31	Do.
Mariner	do	12	South.
Wasp	do	4	Do.
J. W. Flanders	do	7	Do.
Sarah Smith	do	1	Do.
Lydia	Nantucket	2	Do.
Gracie Phillips	Westport	99	East and south.
Village Belle	Newport	74	61 south, 13 east.
White Cloud	New London	35	South.
Conquest	do	60	Do.
Emma	do	75	Caught 36 south and 39 east.
E. C. Berry	do	35	
Hattie Rebecca	Block Island		South; average about 35 fish each.
Laura Louise	do		
Wanita	do		
Annie Godfrey	do		
Mystery	do		
Laura Gammage	do		
Pacific	do		
Yankee Bride	do		
Rose Brothers	do		

The three vessels belonging in Dennis salted their catch before selling it. All the other vessels marketed their catch fresh. The names of some of the other swordfish vessels belonging north of Cape Cod, which

landed fares at Gloucester are: Carrie S. Allen, Black Hawk, Hattie J. Hamblin, Village Maid, Eddie A. Minot, Flying Cloud, Flora Temple, Lizzie W. Hunt, Julietta, Vim, Dreadnaught, Mary H. Lewis, Millie Florence, Fannie T., Helena, Carrie L. Payson, Flying Dart, Carrie E., Charles A. Dyer, A. B. Littlejohn, Eva, W. B. Keene, Mary Hagan, Lizzie Hagan, Ambrose, Lizzie May, Fleur-de-lis, and Frank Clark.

In 1882 the Scud, of Plymouth, captured 128 swordfish. The schooner Florida during the past summer took 10 fish in one day; the Ranger, of Harpswell, 11 in one day, about eight miles off Thatcher's Island.

The wholesale price of fresh swordfish in 1884 averaged 5 cents per pound. The highest price paid was 20 cents per pound, at the beginning of the season; and the lowest, $2\frac{3}{4}$ cents, when they were most abundant. At Gloucester, August 11, the fishermen were paid 5 cents a pound; August 29, $4\frac{1}{2}$ cents; September 7, $3\frac{1}{2}$ cents; September 19, 7 cents; September 29, 10 cents; October 2, $10\frac{1}{2}$ cents; October 6, $10\frac{1}{2}$ cents. At Portland the lowest price was $2\frac{3}{4}$ cents, and the highest 10 cents. At Block Island 20 cents a pound was paid for the first fish caught.

As received from the fishermen, the heads, tails, fins, and entrails are removed; a deduction of 10 pounds is then made in the weight of each fish, and the men paid for only the net weight. The heads are sold to oil-makers at 20 cents each. The swords have no commercial value.

Pickled swordfish, as prepared on the mackerel schooners, or by the few swordfish vessels that salted their catch before landing, was sold to dealers at from \$10 to \$15 per barrel. September 12, at Gloucester, 20 barrels of salt swordfish sold at \$12.50 per barrel.

The greater part of the catch is marketed in fresh condition; whenever, however, there is an overstock, the surplus is brine-salted in the ordinary manner. Swordfish are frequently captured by the mackerel vessels, and are salted, unless the vessel is about making a port, when the fish can be sold fresh. Three hundred pounds of round fish make one barrel or two hundred pounds of the barreled product.

The principal markets for the consumption of this fish are Boston, Providence, New Bedford, New London, and other places in eastern Massachusetts, Rhode Island, and Connecticut. Very little is sold outside of New England.

XVIII.—STATISTICS OF THE UNITED STATES IMPORTS AND EXPORTS OF FISH, FISH-OIL, WHALEBONE, THE TONNAGE OF FISHING VESSELS, ETC., FOR THE YEAR ENDING JUNE 30, 1884.

By CHARLES W. SMILEY.

A.—IMPORTS.

1. Free.—Quantities and values, by countries.
2. Free.—Quantities and values, by customs districts.
3. Dutiable.—Quantities and values, by countries.
4. Dutiable.—Quantities and values, by customs districts.
5. Products of the fisheries.—Quantities and values.
6. Summary for eleven years.—I. Free. II. Dutiable. (Quantities.)
7. Summary for eleven years.—I. Free. II. Dutiable. (Values.)

B.—EXPORTS.

8. Domestic products.—Quantities and values, by countries.
9. Domestic products.—Quantities and values, by customs districts.
10. Foreign products.—Quantities and values, by countries.
11. Foreign products.—Quantities and values, by customs districts.
12. Summary for eleven years.—Quantities. (Domestic products.)
13. Summary for eleven years.—Values. (Domestic products.)
14. Summary for eleven years.—Quantities. (Foreign products.)
15. Summary for eleven years.—Values. (Foreign products.)

C.—TONNAGE.

16. Summary, 1789-1883.—Whale, cod, and mackerel.
17. Cod and mackerel, 1884, by customs districts.
18. Whale, 1884, by customs districts.

The following tables have been prepared, with the assistance of Mr. E. Y. Davidson, from the annual report of the Bureau of Statistics of the Treasury Department, and are based on the custom-house returns:

TABLE I.—*Quantities and values of the fishery-products imported, by countries, into the United States, free of duty, during the year ending June 30, 1884.*

Countries from which imported.	Prepared fish.												
	Cod, haddock, hake, and pollock, dried, smoked, or pickled.		Herring.				Lobsters, canned or preserved.	Mackerel, pickled.		Salmon, pickled.		All other kinds.	Total.
			Dried or smoked.		Pickled.								
	Pounds.	*Dollars.*	*Pounds.*	*Dollars.*	*Barrels.*	*Dollars.*	*Dollars.*	*Barrels.*	*Dollars.*	*Barrels.*	*Dollars.*	*Dollars.*	*Dollars.*
China												1,680	1,680
France												20	20
Germany												4	4
Nova Scotia, N. Brunswick, and Pr. E. Isl'd.	21,672,074	756,885	8,707,479	138,865	71,664	263,151	264,488	83,642	827,203	3,696	60,278	119,917	2,430,787
Quebec, Ontario, Manitoba, and the N. W. T.	263,723	14,855	19,000	475	24,355	105,592	7,370	4,570	46,346	49	914	23,461	199,013
British Columbia												120	120
Newfoundland and Labrador	4,283,795	190,636			30,500	123,718	2,164	3	18	2,663	39,370	37,698	393,604
British West Indies												1,497	1,497
British Honduras												125	125
Hong-Kong												18	18
Italy												2	2
Mexico												1,584	1,584
Cuba												68	68
Total	26,219,592	962,376	8,726,479	139,340	126,519	492,461	274,022	88,215	873,567	6,408	100,562	186,194	3,028,522

TABLE I.—*Quantities and values of the fishery-products imported, by countries, into the United States, free of duty, &c.*—Continued.

Countries from which imported.	Fresh fish.					Minor and secondary products.								Grand total.
	All kinds except salmon.		Salmon.		Total.	Coral.	Fish-oil and whale-oil.		Fish-sounds or fish-bladders.		Whalebone.		Total.	
	Pounds.	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*	*Gallons.*	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.**	*Dollars.*
China														1,680
France														20
Germany														4
Nova Scotia, N. Brunswick, and Pr. E. Isl'd	6,309,913	183,819	745,575	91,119	274,938		256,038	116,249					116,249	2,821,974
Quebec, Ontario, Manitoba, and the N. W. T	11,073,416	392,756	266,807	28,084	420,840		26,572	30,442					30,442	650,295
British Columbia	700	47			47									167
Newfoundland and Labrador	120,500	616	4,555	447	1,063		146,701	96,418					96,418	491,085
British West Indies														1,497
British Honduras														125
Hong-Kong														18
Italy														2
Mexico	16,890	846			846		250	100					100	2,530
Cuba														68
All other countries						167			268,752	92,910	32,709	29,438	122,515	122,515
Total	17,521,419	578,084	1,016,937	119,650	697,734	167	429,561	243,209	268,752	92,910	32,709	29,438	365,724	4,091,980

TABLE II.—*Quantities and values of the fishery-products imported, by customs districts, into the United States, free of duty, during the year ending June 30, 1884.*

Customs districts into which imported.	Prepared fish.												
	Cod, haddock, hake and pollock, dried, smoked, or pickled.		Herring.				Lobsters, canned or preserved.	Mackerel, Pickled.		Salmon. Pickled.		All other kinds.	Total.
			Dried or smoked.		Pickled.								
	Pounds.	*Dollars.*	*Pounds.*	*Dollars.*	*Barrels.*	*Dollars.*	*Dollars.*	*Barrels.*	*Dollars.*	*Barrels.*	*Dollars.*	*Dollars.*	*Dollars.*
Alexandria, Va					100	309		10	87				396
Baltimore, Md	11,300	622			919	4,103				24	500	6	5,231
Bangor, Me	30,030	1,350	224,963	4,864	334	1,084	7,379	1,755	16,641			17,268	48,586
Barnstable, Mass	302,360	6,509											6,509
Belfast, Me												270	270
Boston and Charlestown, Mass	12,345,360	450,624	3,626,784	62,168	80,442	300,035	63,882	69,477	677,544	3,433	57,333	59,741	1,671,327
Buffalo Creek, N. Y					1,000	5,250							5,250
Champlain, N. Y	57,940	3,237			151	697				26	384	213	4,531
Chicago, Ill					5,042	24,473							24,473
Detroit, Mich	15,000	600						78	1,600			461	2,661
Duluth, Minn										6	54		54
Gloucester, Mass	2,794,600	73,081	133,000	1,716				941	9,324				84,121
Huron, Mich	84,105	5,782	19,000	475	8,793	37,644	7,370	4,492	44,746			17,456	115,473
Key West, Fla												319	319
Machias, Me	4,000	110	1,840	33	6	11							154
Milwaukee, Wis					2,100	10,650							10,650
Minnesota, Minn					200	1,050							1,050
New York, N. Y	8,022,582	334,489	788,512	10,171	16,486	71,174	51,277	6,293	73,724	2,902	41,815	43,746	626,396
Oswegatchie, N. Y	26,325	1,314			4,589	19,319						2,568	23,201
Paso del Norte, Tex. and N. Mex												30	30
Passamaquoddy, Me	1,169,421	33,114	3,781,850	56,882	6,311	16,510	24,817	4,910	48,136			36,411	215,870
Philadelphia, Pa							2,250					8	2,258
Portland and Falmouth, Me	940,236	31,531	138,530	2,783	30	120	117,047	259	1,765			1,638	154,884
Portsmouth, N. H			1,600	40									40
Salem and Beverly, Mass	130,100	4,012			16	32							4,044
San Francisco, Cal												3,154	3,154
Savannah, Ga	227,936	12,824											12,824
Superior, Mich												2,540	2,540
Vermont, Vt	56,161	2,790								17	476	200	3,466
Waldoborough, Me	12,136	387	10,400	208									595
Yorktown, Va												125	125
All other customs districts												40	40
Total	26,219,592	962,376	8,726,479	139,340	126,519	492,461	274,022	88,215	873,567	6,408	100,562	186,194	3,028,522

TABLE II.—*Quantities and values of the fishery-product imported, by customs districts, into the United States, free of duty, &c.*—Continued.

Customs districts into which imported.	Fresh fish.					Minor and secondary products.								Grand total.
	All kinds except salmon.		Salmon.		Total.	Coral.	Fish-oil and whale-oil.		Fish-sounds or fish-bladders.		Whalebone.		Total.	
	Pounds.	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*	*Gallons.*	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*
Alexandria, Va														396
Baltimore, Md							3, 940	2, 088					2, 088	7, 319
Bangor, Me	3, 102, 079	100, 493	74, 008	12, 051	112, 544		80	50					50	161, 180
Barnstable, Mass							689	384					384	6, 893
Belfast, Me														270
Boston and Charlestown, Mass	1, 419, 842	45, 515	35, 856	6, 163	51, 678		199, 395	90, 998	58, 504	28, 337	3, 408	610	119, 945	1, 842, 950
Buffalo Creek, N. Y	2, 483, 751	96, 978			96, 978									102, 228
Cape Vincent, N. Y	917, 340	45, 750			45, 850									45, 850
Champlain, N. Y	600, 723	28, 896	239, 672	25, 570	54, 466		4, 409	5, 492					5, 492	64, 489
Chicago, Ill							2, 067	2, 939					2, 939	27, 412
Cuyahoga, Ohio	7, 000	110			110									110
Detroit, Mich	2, 220, 899	55, 374			55, 374		1, 664	654	141	52			706	58, 741
Duluth, Minn	86, 251	3, 090			3, 090									3, 144
Genesee, N. Y	199, 010	9, 869			9, 869									9, 869
Gloucester, Mass	242, 000	1, 275			1, 275		20, 067	10, 167					10, 167	95, 763
Huron, Mich	648, 609	22, 676			22, 676		2, 096	1, 280					1, 280	137, 429
Key West, Fla														319
Machias, Me														154
Michigan, Mich	798, 211	27, 087			27, 087									27, 087
Milwaukee, Wis														10, 650
Minnesota, Minn	800, 581	27, 259			27, 259									28, 369
New York, N. Y	120, 000	600	25	5	605	10	142, 434	96, 178	194, 161	56, 853	4, 488	326	153, 367	780, 368
Niagara, N. Y	590, 425	23, 617			23, 617									23, 617
Oswegatchie, N. Y	37, 375	1, 292			1, 292		4, 297	6, 176					6, 176	30, 669
Oswego, N. Y	86, 540	3, 434			3, 434									3, 434
Paso del Norte, Tex. and N. Mex	16, 890	846			846									876
Passamaquoddy, Me	1, 486, 675	35, 839	640, 241	73, 347	109, 186		29, 249	10, 169	15, 176	7, 429			17, 598	342, 654
Philadelphia, Pa						10							10	2, 268
Portland and Falmouth, Me	23, 750	618			618		6, 840	2, 633					2, 633	158, 135
Portsmouth, N. H	35, 667	70			70									110
Salem and Beverly, Mass														4, 044
San Diego, Cal							250	100					100	100
Sandusky, Ohio	789, 208	18, 065			18, 065									18, 065
San Francisco, Cal											24, 813	28, 502	28, 502	31, 656
Savannah, Ga														12, 824
Superior, Mich	534, 022	15, 499			15, 499									18, 039
Vermont, Vt	272, 453	13, 623	27, 135	2, 514	16, 137		12, 039	13, 901					13, 901	33, 504
Waldoborough, Me														595
Yorktown, Va														125
All other customs districts	2, 118	109			109	147			770	239			386	535
Total	17, 521, 419	578, 084	1, 016, 937	119, 650	697, 734	167	429, 516	243, 209	268, 752	92, 910	32, 709	29, 438	365, 724	4, 091, 980

TABLE III.—*Quantities and values of the dutiable fishery-products imported, by countries, into the United States during the year ending June 30, 1884.*

Countries from which imported.	Fish.					Minor and secondary products.					Grand total.
	Herring, pickled or salted.		Anchovies and sardines, packed in oil or otherwise.	All other kinds.	Total.	Fish-oil and whale-oil.		Sponges.	Whalebone.	Total.	
	Barrels.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Gallons.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Austria			10,555		10,555			9,943		9,943	20,498
Brazil						55	32			32	32
China				57,329	57,329	380	162			162	57,491
Denmark	19	214	83	1,380	1,677						1,677
France	170	1,228	946,098	17,895	965,221	40,830	5,950	12,264		18,214	983,435
French Possessions, all other				145	145						145
Germany	8,971	105,263	6,529	46,401	158,193	12,057	16,113	1,156		17,269	175,462
England	450	3,236	51,895	5,743	60,874	4,570	5,518	65,553		71,071	131,945
Scotland	43	632		1,664	2,296			88		88	2,384
Ireland	15	156			156						156
Gibraltar			8		8						8
Nova Scotia, New Brunswick, and Prince Edward Island				20	20	3,645	1,535			1,535	1,555
Quebec, Ontario, Manitoba, and the N. W. Territory	456	2,282	6	44,093	46,381	422	320	907		1,227	47,608
British Columbia				106,944	106,944	45,712	14,308			14,308	121,252
Newfoundland and Labrador				34	34						34
British West Indies				270	270	55	48	165,851		165,899	166,169
British East Indies								3,753		3,753	3,753
Hong-Kong				5,835	5,835	1,960	446			446	6,281
British Possessions in Australasia				3,498	3,498						3,498
Greece								230		230	230
Italy			3,701	3,665	7,366						7,366
Japan				805	805	241,105	56,148			56,148	56,953
Mexico			1	1,407	1,408			350		350	1,758
Netherlands	18,241	236,263	6,030	94,563	336,856						336,856
Portugal			9,552	1,923	11,475						11,475
Azore, Madeira, and Cape Verde Islands				24	24	6,192	1,168			1,168	1,192
Russia, Asiatic				138	138	3,000	630			630	768
Spain			2,233	170	2,403						2,403
Cuba			517	1,619	2,136	2	5	30,469		30,474	32,610
Sweden and Norway	2,643	16,308	3,455	50,784	70,547	23,334	34,471			34,471	105,018
Turkey in Europe								1,016		1,016	1,016
Turkey in Asia				18	18			279		279	297
Venezuela				17	17						17
All other countries									1,090	1,090	1,090
Total	31,008	365,582	1,040,663	446,384	1,852,629	383,319	136,851	291,859	1,090	429,803	2,282,432

TABLE IV.—*Quantities and values of the dutiable fishery-products imported, by customs districts, into the United States during the year ending June 30, 1884.*

Customs districts into which imported.	Fish.					Minor and secondary products.					Grand total.
	Herring, pickled or salted.		Anchovies and sardines, packed in oil or otherwise.	All other kinds.	Total.	Fish-oil and whale-oil.		Sponges.	Whalebone.	Total.	
	Barrels.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Gallons.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Baltimore, Md			3, 636	3, 057	6, 693						6, 693
Boston and Charlestown, Mass	20	506	116, 722	657	117, 885	740	370	219		589	118, 474
Buffalo Creek, N. Y	88	481		2, 690	3, 171						3, 171
Champlain, N. Y				5	5	410	313	907		1, 220	1, 225
Detroit, Mich	349	1, 685	1	15, 809	17, 495						17, 495
Galveston, Tex			4, 996		4, 996						4, 996
Huron, Mich				8, 064	8, 064						8, 064
Key West, Fla			479	1, 844	2, 323	2	5	359		364	2, 687
Michigan, Mich				500	500						500
Minnesota, Minn			5	2, 039	2, 044						2, 044
New Bedford, Mass						6, 192	1, 168			1, 168	1, 168
New Orleans, La	17	347	166, 554	4, 734	171, 635			91	2	93	171, 728
New York, N. Y	30, 515	362, 447	672, 051	215, 242	1, 249, 740	158, 837	80, 278	284, 888	1, 088	366, 254	1, 615, 994
Oswegatchie, N. Y	1	4		1, 344	1, 348						1, 348
Paso del Norte, Tex. and N. Mex				165	165						165
Philadelphia, Pa			8, 729	41	8, 770	605	1, 120	4, 842		5, 962	14, 732
Puget Sound, Wash				240	240	15, 859	5, 082			5, 082	5, 322
San Diego, Cal				764	764						764
Sandusky, Ohio				7, 767	7, 767	12	7			7	7, 774
San Francisco, Cal			67, 421	170, 280	237, 701	188, 657	44, 006	483		44, 489	282, 190
Superior, Mich				5, 557	5, 557						5, 557
Vermont, Vt	8	37		270	307						307
Willamette, Oreg				5, 207	5, 207	12, 000	4, 500			4, 500	9, 707
All other customs districts	10	75	69	108	252	5	5	70		75	327
Total	31, 008	365, 582	1, 040, 663	446, 384	1, 852, 629	383, 319	136, 854	291, 859	1, 090	429, 803	2, 282, 432

TABLE V.—*Quantities and values of the products of the fisheries, taken by American vessels and fishermen, brought into the United States during the year ending June 30, 1884.*

Products.	Quantities.	Values.
		Dollars.
Of the whale fisheries:		
Sperm-oil ......gallons..	802, 117	780, 828
Other whale-oil ......do....	664, 589	367, 513
Whalebone or baleen, split or unsplit ......pounds..	185, 317	352, 964
Ambergris ......do....	31	4, 960
Other products of American whale-fisheries	......	11, 088
Total	......	1, 517, 353
Of other fisheries:*		
Codfish, cured ......cwts..	301, 032	1, 072, 003
Mackerel, cured ......do....	153, 632	618, 331
Herring, cured ......do....	122, 483	191, 920
Other fish, cured ......do....	45, 987	152, 134
Oysters ......bushels..	20, 060	24, 541
Other shell-fish	......	247, 298
Fresh fish (not shell-fish) ......pounds..	48, 537, 452	1, 339, 443
Oils, other than whale ......gallons..	1, 223, 231	430, 675
Shell and bone, other than whalebone	......	140
Teeth ......pounds..	31, 407	21, 248
Skins ......number..	11, 213	6, 975
Manures ......tons..	32, 793	590, 977
All other products of the American fisheries	......	35, 358
Total	......	4, 731, 043
Total value of products of the American fisheries	......	6, 248, 396

*This information in regard to fishery-products other than whale is incomplete, owing to the fact that there is no law requiring all products of the fisheries to be reported to the customs officers when landed within a customs district. It is compiled chiefly from information obtained through the personal efforts and inquiries of the customs officers of the several ports from which it is practicable to obtain returns.

TABLE VI.—*Quantities of certain kinds of fish and oil imported into the United States during the eleven years ending June 30, 1884.*

	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	Total.
I.—FREE OF DUTY.												
Fish, not of American fisheries:												
Fresh, of all kinds ......pounds..	9, 587, 595	15, 308, 769	10, 723, 216	7, 735, 981	9, 681, 828	8, 432, 835	10, 761, 307	12, 975, 761	15, 893, 849	16, 368, 476	18, 538, 356	136, 007, 973
Herring, pickled ....barrels..	51, 423	70, 763	87, 554	63, 280	58, 082	55, 732	46, 723	64, 811	76, 136	101, 344	126, 519	802, 367
Mackerel, pickled ......barrels..	89, 503	77, 479	76, 531	43, 066	102, 148	101, 420	112, 468	120, 288	58, 279	52, 093	88, 215	921, 490
Oils:												
Whale and fish, not of American fisheries ....gallons..	165, 448	277, 739	103, 184	138, 708	311, 091	182, 625	407, 416	568, 660	337, 076	326, 608	429, 561	3, 248, 116
II.—DUTIABLE.												
Fish, not of American fisheries:												
Herring.................barrels..	31, 128	21, 581	17, 268	14, 873	15, 542	18, 950	26, 168	30, 987	36, 061	48, 833	365, 582	626, 973
Mackerel..................do....	190	59	7	14	6	2	....	9	164	19	....	470
Oils:												
Whale and fish, not of American fisheries.............gallons..	226, 528	115, 084	102, 883	51, 882	85, 509	61, 509	92, 819	146, 410	209, 051	156, 022	383, 319	1, 631, 016

TABLE VII.—*Values of fish and oil imported into the United States during the eleven years ending June 30, 1884.*

	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	Total.
I.—FREE OF DUTY.												
Fish, not of American fisheries:												
Fresh, of all kinds	$294, 837	$351, 889	$271, 597	$236, 098	$339, 561	$283, 827	$320, 403	$376, 508	$488, 925	$572, 526	$697, 734	$4, 233, 905
Herring, pickled..................	181, 521	288, 590	306, 555	210, 786	230, 533	192, 069	154, 003	236, 402	265, 797	418, 323	492, 461	2, 977, 041
Mackerel, pickled	800, 920	584, 283	695, 412	372, 260	907, 246	649, 721	493, 059	614, 729	396, 149	427, 327	873, 567	6, 814, 673
All other not elsewhere specified.	553, 949	928, 344	501, 154	581, 592	637, 437	763, 915	912, 336	1, 088, 336	1, 366, 963	1, 774, 646	1, 662, 494	10, 771, 166
Oils:												
Whale and fish, not of American fisheries	91, 944	161, 289	62, 438	84, 088	176, 384	80, 701	170, 525	293, 600	158, 878	203, 611	243, 209	1, 726, 667
Total	1, 923, 171	2, 314, 395	1, 837, 156	1, 484, 824	2, 291, 161	1, 970, 233	2, 050, 326	2, 609, 576	2, 676, 712	3, 396, 433	3, 969, 465	26, 523, 452
II.—DUTIABLE.												
Fish, not of American fisheries:												
Herring, pickled..................	253, 044	226, 494	186, 535	189, 615	180, 840	189, 204	288, 407	290, 073	375, 617	498, 976	365, 582	3, 044, 387
Mackerel, pickled	1, 550	553	48	148	67	14	....	97	1, 179	148	....	3, 804
Sardines and anchovies preserved in oil or otherwise	991, 030	526, 179	595, 901	773, 331	677, 910	912, 391	1, 102, 410	987, 394	860, 760	911, 668	1, 040, 663	9, 379, 637
All other not elsewhere specified.	131, 676	102, 283	96, 046	91, 654	149, 852	118, 050	132, 684	142, 158	294, 606	322, 063	446, 384	2, 027, 456
Oils:												
Whale and fish, not of American fisheries	121, 927	70, 404	63, 286	44, 015	56, 616	45, 903	55, 133	82, 584	103, 020	76, 553	136, 854	856, 295
Total	1, 499, 227	925, 913	941, 816	1, 098, 763	1, 065, 285	1, 265, 562	1, 578, 634	1, 502, 306	1, 635, 182	1, 809, 408	1, 989, 483	15, 311, 579

TABLE VIII.—*Quantities and values of the domestic fishery-products exported, by countries, from the United States during the year ending June 30, 1884.*

Countries to which exported.	Fish, fresh, not elsewhere specified.		Salmon other than canned.	Prepared fish. Dried, smoked, and cured. Codfish, haddock, hake, and pollock.		Dried, smoked, and cured. Fish not elsewhere specified.		Pickled. Mackerel.		Pickled. Fish not elsewhere specified.		Salmon, canned.	Total.
	Pounds.	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*	*Barrels.*	*Dollars.*	*Barrels.*	*Dollars.*	*Dollars.*	*Dollars.*
Argentine Republic			15	400	33	34,556	2,955	1	6			2,140	5,134
Belgium						168	29						29
Brazil			64	15,020	787	23,057	2,566	4	50	78	1,025	1,171	5,599
Central American States			719	182,410	11,467	62,009	6,547	204	2,336	80	696	4,779	25,825
Chili				2,500	170	3,456	415					7,394	7,979
China				2,900	184	4,916	447					1,909	2,540
Denmark				995	63	448	63						126
Danish West Indies			51	95,361	3,500	11,266	509	4	50	394	1,953	324	6,336
France				600	48	535	56			2,080	14,697	6,354	21,155
French West Indies			851	1,304,616	50,891	250,619	7,314	2,444	15,619	1,373	5,165	605	79,594
French Guiana			124	723,332	25,093	284,164	7,749	227	1,764	126	623	397	35,626
French Poss. in Africa and adjacent is'ds						1,000	52						52
French Possessions, all other			5,060	4,740	289					7	104	15,747	16,140
Germany			663	1,185	77	658,699	107,524			19	230	2,519	110,350
England			11,659	29,643	1,096	110,878	5,650	93	1,105	1,429	6,084	1,774,340	1,788,275
Scotland						44,689	1,697					304	2,001
Gibraltar						488	53						53
N. Scotia, N. Brunswick, and Pr. Ed. Is'd	30,500	845		612,100	13,995	130,810	2,848	833	4,545	582	1,948	75	23,411
Quebec, Ontario, Manitoba, and N. W. T.	1,322,660	41,487	10,884	115,867	6,466	429,798	26,994	17	168	1,028	8,600	533	42,761
British Columbia	200	10		50,340	2,754	30,943	1,751			4	38	11	4,554
Newfoundland and Labrador						50	6						6
British West Indies	9,000	481	9,993	1,654,376	76,110	255,525	14,525	1,582	12,411	5,540	27,010	5,996	136,052
British Guiana	4,700	358	627	22,068	870	12,046	367	238	2,222	208	1,133	6,650	11,242
British Honduras			74	157,428	6,813	25,355	1,987	151	1,600	6	48	649	11,097
British East Indies						1,680	247					789	1,036
Hong-Kong				34,380	2,123	1,149,579	63,947					11,044	77,114
British Poss. in Africa and adjacent is'ds			15	14,200	375	82,736	2,777	90	680	85	409	727	4,968
British Possessions in Australasia			14,105	71,930	4,874	27,017	2,425			882	4,392	401,679	413,370
Hawaiian Islands			41,464	121,765	7,500	271,857	16,166			739	7,958	28,242	59,866
Hayti	312	43	101	3,889,650	205,406	595,545	21,513	4,244	34,845	15,086	94,010	223	355,997
Italy						2,110	210					396	606
Japan				2,410	153	126	8					2,140	2,301
Liberia			90	60,695	2,546	65,725	2,565	574	5,674	598	3,381	90	14,256
Mexico			1,830	47,577	3,070	57,544	3,221	7	53	22	150	9,593	16,087
Netherlands			25	25,333	1,520								1,520
Dutch West Indies			191	70,189	4,098	29,716	1,245	106	1,066	54	233	1,019	7,661

Dutch Guiana				1, 056, 709	37, 137	677, 820	23, 601	2	25	1, 005	5, 633	64	66, 460
Dutch East Indies												1, 658	1, 658
Peru			600	4, 150	275	31, 335	3, 089	4	35			3, 710	7, 109
Azore, Madeira, and Cape Verde Islands				81, 806	3, 060	8, 650	248	3	12			31	3, 351
Russia, Asiatic												75	75
San Domingo				516, 195	29, 894	182, 272	7, 395	818	7, 115	54	355	354	45, 113
Spain												113	113
Cuba	273, 689	18, 785	60	2, 560, 934	142, 114	1, 174, 434	42, 221	209	1, 799	33	202	436	186, 772
Porto Rico			1, 206	217, 244	12, 376	98, 768	3, 564	257	1, 984	175	1, 155	659	19, 738
Spanish Poss. in Africa and adjacent is'ds				900	56	2, 750	110					180	346
Spanish Possessions, all other				1, 250	128							1, 165	1, 293
Turkey in Europe						9, 744	1, 120						1, 120
Turkey in Asia						7, 991	960						960
United States of Colombia			6, 584	1, 057, 052	70, 961	241, 650	21, 455	934	12, 255	233	1, 599	11, 820	118, 090
Uruguay						28, 180	1, 266					5	1, 271
Venezuela			314	92, 853	5, 042	29, 157	1, 336	54	508			4, 743	11, 629
All other countries and ports in S. A.				25, 280	1, 487	21, 687	2, 161	2	23	12	115	2, 528	6, 314
All other islands and ports			3, 162	740	45	784	52					7, 646	7, 743
Total	1, 641, 061	62, 009	110, 531	14, 929, 123	734, 946	7, 174, 332	415, 006	13, 102	107, 950	31, 932	188, 946	2, 323, 026	3, 769, 874

TABLE VIII.—*Quantities and values of the domestic fishery-products exported, by countries, from the United States, &c.*—Continued.

Countries to which exported.	Shell-fish.			Minor and secondary products.													Grand total.
	Oysters.	All other kinds.	Total.	Fish-glue.	Fish-s'nds.	Oil. Sperm.		Oil. Other whale and fish.		Spermaceti and spermaceti wax.		Sponges.		Whalebone.		Total.	
	Dollars.	*Dollars.*	*Dollars.*	*Dolls.*	*Dolls.*	*Gallons.*	*Dollars.*	*Gallons.*	*Dollars.*	*Pounds.*	*Dolls.*	*Lbs.*	*Dolls.*	*Lbs.*	*Dollars.*	*Dollars.*	*Dollars.*
Argentine Republic	13,523	3,788	17,301														22,450
Belgium	1,121	450	1,571			200	230	453	673					2,809	8,578	9,481	11,081
Brazil	838	2,360	3,198			296	375									375	9,236
Central American States	1,679	1,201	2,880			16	23	470	256							279	29,703
Chili	4,291	4,385	8,670					7	8							8	16,663
China		38	38														2,578
Denmark	51	3,135	3,186											542	2,439	2,439	5,751
Danish West Indies	362	79	441														6,828
France	1,083	20,955	22,038					113,840	58,670	4,080	740			33,971	136,354	195,764	238,957
French West Indies																	80,445
French Guiana		133	133														35,883
Miquelon, Langley, and St. Pierre Is'ds		255	255														255
French Poss. in Africa and adjacent is'ds																	52
French Possessions, all other	87	165	252														21,452
Germany	28,303	7,533	35,836			1,485	1,646	29,004	10,984	125,226	23,393			37,943	125,787	161,810	308,659
England	349,706	12,171	361,877			250,746	233,977	256,344	74,843	64,254	11,888			17,388	46,350	367,058	2,528,869
Scotland	5,491		5,491			87,607	87,431	21,794	12,837	66,143	12,484					112,752	120,244
Gibraltar	6	6	12														65
N. Scotia, N. Brunswick, and Pr. Ed. Is'd	5,705	31,338	37,043			50	56	711	461							517	61,816
Quebec, Ontario, Manitoba, and N. W. T.	86,375	3,933	90,308			2,195	1,144	14,060	6,440							7,584	193,024
British Columbia	9,230	2,588	11,818			40	48	3,784	1,131							1,179	17,561
Newfoundland and Labrador	319		319														325
British West Indies	2,607	936	3,543					1,485	823							823	150,892
British Guiana	743	83	826														13,053
British Honduras	179	155	334														11,505
British East Indies	32	104	136														1,172
Hong-Kong	17	87,280	87,297					4,643	2,479							2,479	166,890
British Poss. in Africa and adjacent is'ds	692	784	1,476														6,459
British Possessions in Australasia	17,498	6,550	24,048					33,038	16,032							16,032	467,555
Hawaiian Islands	6,008	15,259	21,267					244	110							110	122,707
Hayti	1,105	61	1,166			60	63	94	40							103	357,410
Italy		62	62					137	91							91	759
Japan		132	132														2,433
Liberia																	14,346
Mexico	8,515	5,180	13,695			98	102	2,748	1,446	244	48					1,596	33,208
Netherlands	298	375	673					5,000	2,695							2,695	4,913

Dutch West Indies	379		379			119	121									121	8,352
Dutch Guiana																	66,460
Dutch East Indies																	1,658
Peru	1,669	3,254	4,923														12,632
Azore, Madeira, and Cape Verde Islands																	3,351
Russia, Asiatic																	75
San Domingo	249	220	469					51	26							26	45,608
Spain	35	18	53														166
Cuba	4,513	116	4,629			46	37	763	533							570	210,816
Porto Rico	533	47	580														21,524
Spanish Poss. in Africa and adjacent is'ds																	346
Spanish Possessions, all other																	1,293
Turkey in Europe																	1,120
Turkey in Asia																	960
United States of Colombia	2,971	7,630	10,601			62	72	245	126							198	135,473
Uruguay	7,234	1,637	8,871														10,142
Venezuela	2,634	977	3,611			49	60									60	15,614
All other countries and ports in S. A.	6,157	2,292	8,449														14,763
All other islands and ports	249	375	624														11,529
Miscellaneous				2,221	800							17,480	9,472			12,493	12,493
Total	572,487	228,030	800,517	2,221	800	343,069	325,385	488,915	190,704	259,947	48,553	17,480	9,472	92,653	319,508	896,643	5,639,574

TABLE IX.—*Quantities and values of the domestic fishery-products exported, by customs districts, during the year ending June 30, 1884.*

Customs districts from which exported.	Fish, fresh, not elsewhere specified.		Prepared fish.										
			Salmon other than canned.	Dried, smoked, and cured.				Pickled.				Salmon, canned.	Total.
				Codfish, haddock, hake, and pollock.		Fish, not elsewhere specified.		Mackerel.		Fish, not elsewhere specified.			
	Pounds.	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*	*Barrels.*	*Dollars.*	*Barrels.*	*Dollars.*	*Dollars.*	*Dollars.*
Baltimore, Md			30	12,836	558	16,630	493	69	592	10	40	4,149	5,832
Bangor, Me			15			1,280	50			10	106		156
Barnstable, Mass				185,360	4,138								4,138
Belfast, Me	312	43										8	8
Boston and Charlestown, Mass	13,700	839	4,165	2,967,372	106,232	1,338,907	43,638	4,356	28,517	8,437	44,306	21,986	244,679
Brazos de Santiago, Tex			784	3,279	405	250	50			1	20	717	1,192
Cape Vincent, N. Y						7,200	360						360
Corpus Christi, Tex			29	1,550	160	3,200	265	1	6	20	100	1,731	2,262
Detroit, Mich	2,783	167				4,587	367			2	16		383
Duluth, Minn						50	9			1	10		19
Galveston, Tex												100	100
Humboldt, Cal						3,000	395					2,121	2,516
Huron, Mich			10,394	58,650	3,193							500	3,693
Key West, Fla	268,806	18,038				988,175	34,335						34,335
Minnesota, Minn	50	4	386	54,317	3,127	25,260	1,388	17	168	44	339	33	5,055
New Bedford, Mass				5,568	160			3	12				172
New Haven, Conn				59,400	2,287					357	1,738		4,025
New Orleans, La			928	30,806	1,862	825	158	75	802			7,009	9,831
New York, N. Y	4,883	747	27,443	10,506,343	572,673	2,761,825	221,972	8,077	74,678	19,804	118,399	47,953	1,035,675
Oregon, Oreg						13,212	1,388			12	115	1,486,992	1,488,495
Oswegatchie, N. Y	4,213	283				3,320	100						100
Oswego, N. Y										1	10		10
Passamaquoddy, Me	30,500	845		173,560	3,365	135,810	2,857			13	32		6,254
Philadelphia, Pa			169	20,100	800	7,547	597	232	1,832	211	1,840		5,069
Portland and Falmouth, Me				546,417	17,201	20,370	665	271	1,339	488	2,013		21,218
Puget Sound, Wash	200	10	1,000	11,590	403	885	45			5	43	8,730	9,221
Saluria, Tex						4,128	220	1	4			6	230
San Diego, Cal										1	30	86	116
San Francisco, Cal			64,874	289,015	18,231	1,448,490	80,884			1,482	11,369	740,645	851,129
Vermont, Vt	1,315,414	41,016	104	2,900	146	389,381	24,770			980	8,225		33,141
Willamette, Oreg			210	60	5							250	255
Wiscasset, Me										53	195		195
All other customs districts	200	17										10	10
Total	1,641,061	62,069	110,531	14,929,123	734,946	7,174,332	415,006	13,102	107,950	31,932	188,946	2,323,026	3,769,874

Customs districts from which exported.	Shell-fish.			Minor and secondary products.													Grand total.
	Oysters.	All other kinds.	Total.	Fish-glue.	Fish-sounds.	Oil.				Spermaceti and spermaceti wax.		Sponges.		Whalebone.		Total.	
						Sperm.		Other whale and fish.									
	Dollars.	Dollars.	Dollars.	Dolls.	Dollars.	Gallons.	Dollars.	Gallons.	Dollars.	Pounds.	Dollars.	Pounds.	Dollars.	Pounds	Dollars.	Dollars.	Dollars.
Baltimore, Md	41,228	343	41,571														47,433
Bangor, Me																	171
Barnstable, Mass																	4,138
Belfast, Me	63		63														114
Boston and Charlestown, Mass	4,134	12,049	16,183	2,221	800	60,849	61,591	6,090	3,035					12,771	33,100	100,747	366,613
Brazos de Santiago, Tex	12	13	25					35	31							31	2,032
Buffalo Creek, N. Y	28,866		28,866														28,866
Cape Vincent, N. Y	7,971		7,971														8,331
Castine, Me		325	325														325
Champlain, N. Y	10,000		10,000					11,024	4,831							4,831	14,831
Corpus Christi, Tex	130	30	160			20	15	45	25							40	2,491
Detroit, Mich	3,759		3,759														4,309
Duluth, Minn	393		393														412
Galveston, Tex	420		420														520
Humboldt, Cal	140	10	150														2,666
Huron, Mich																	14,087
Key West, Fla		24	24					240	240							240	52,637
Minnesota, Minn	19,944	148	20,092			2,135	1,082									1,082	26,619
New Bedford, Mass																	172
New Haven, Conn																	4,025
New Orleans, La	445	951	1,396														12,155
New York, N. Y	421,345	76,338	497,683			279,965	262,587	442,470	169,245	259,947	48,553	17,430	9,437	79,882	286,408	776,230	2,337,778
Oregon, Oreg																	1,488,495
Oswegatchie, N. Y	11,994		11,994														12,377
Oswego, N. Y	43	8	51			40	28	3,036	1,609							1,637	1,698
Passamaquoddy, Me	1,170	428	1,598														8,697
Philadelphia, Pa	340		340														5,578
Portland and Falmouth, Me		21,648	21,648														42,866
Puget Sound, Wash	4,283	243	4,526														14,757
Saluria, Tex	12		12														242
San Diego, Cal																	116
San Francisco, Cal	12,386	111,522	123,908			40	48	25,975	11,688							11,736	1,051,647
Vermont, Vt	3,405	3,777	7,182			20	34									34	81,477
Willamette, Oreg		35	35														500
Wiscasset, Me																	195
All other customs districts	4	138	142									50	35			35	204
Total	572,487	228,030	800,517	2,221	800	343,069	325,385	488,915	190,704	259,947	48,553	17,480	9,472	92,653	319,508	896,643	5,639,574

TABLE X.—*Quantities and values of the foreign fishery-products exported, by countries, from the United States during the year ending June 30, 1884.*

Countries to which exported.	Free of duty.												
	Fish.												Total.
	Cod, haddock, hake, and pollock, dried, smoked, or pickled.		Herring.				Lobsters, canned or preserved.	Mackerel, pickled.		Salmon, pickled.		All other kinds.	
			Dried or smoked.		Pickled.								
	Pounds	*Dollars.*	*Pounds.*	*Dollars.*	*Barrels.*	*Dollars.*	*Dollars.*	*Barrels.*	*Dollars.*	*Barrels.*	*Dollars.*	*Dollars.*	*Dollars.*
Argentine Republic												398	398
Belgium												2,050	2,050
Central American States													
Chili							117					3,053	3,170
France							5,152					30,190	35,342
French possessions													
Germany												865	865
England	115,808	2,587	6,335	300			4,577					16,697	24,161
Nova Scotia, New Brunswick, and Prince Edward Island	49,950	3,000	5,200	83	713	2,556		32	145				5,784
Quebec, Ontario, Manitoba, and the Northwest Territory							5,740						5,740
British Columbia													
British West Indies	523,650	27,512			280	2,085						19,424	49,021
British Guiana										30	389		389
British Honduras													
British Possessions in Africa and adjacent islands	5,000	200											200
British Posessions in Australasia							2,135					5,496	7,631
Hawaiian Islands													
Hayti												135	135
Mexico												3,348	3,348
Netherlands												86	86
Dutch West Indies												19	19
Peru							550					235	785
San Domingo													
Cuba	1,032,959	45,202										29,002	74,204
Porto Rico	70,000	2,750											2,750
Sweden and Norway												2,750	2,750
United States of Colombia	400	30										1,015	1,045
Uruguay													
All other countries and ports in South America												398	398
All other islands and ports													
Total	1,797,767	81,281	11,535	383	993	4,641	18,271	32	145	30	389	115,161	220,271

Countries to which exported.	Dutiable.								
	Fish.			Minor and secondary products.					
	Anchovies and sardines, packed in oil or otherwise.	All other kinds.	Total.	Fish-oil and whale-oil.		Sponges.	Total.	Total.	Grand total.
	Dollars.	Dollars.	Dollars.	Gallons.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.
Argentine Republic						140	140	140	538
Belgium						181	181	181	2, 231
Central American States	2, 282	288	2, 570					2, 570	2, 570
Chili						40	40	40	3, 210
France	200	16, 769	16, 969			12, 456	12, 456	29, 425	64, 767
French possessions	1, 385	254	1, 639					1, 639	1, 639
Germany				850	1, 660	11, 604	13, 264	13, 264	14, 129
England	7, 340	1, 590	8, 930			6, 246	6, 246	15, 176	39, 337
Nova Scotia, New Brunswick, and Prince Edward Island									5, 784
Quebec, Ontario, Manitoba, and the Northwest Territory	3, 053	108, 228	111, 281	140	164	5, 806	5, 970	117, 251	122, 991
British Columbia	1, 895	1, 960	3, 855					3, 855	3, 855
British West Indies	54	166	220					220	49, 241
British Guiana									389
British Honduras	227	281	508			2	2	510	510
British Possessions in Africa and adjacent islands									200
British Possessions in Australasia				15, 615	4, 704		4, 704	4, 704	12, 335
Hawaiian Islands	1, 583	3, 583	5, 166					5, 166	5, 166
Hayti									135
Mexico	5, 340	1, 439	6, 779			48	48	6, 827	10, 175
Netherlands						2, 506	2, 506	2, 506	2, 592
Dutch West Indies									19
Peru		598	598					598	1, 383
San Domingo	369	115	484					484	484
Cuba		16, 762	16, 762					16, 762	90, 966
Porto Rico									2, 750
Sweden and Norway									2, 750
United States of Colombia	1, 252	3, 816	5, 068	220	164		164	5, 232	6, 277
Uruguay						676	676	676	676
All other countries and ports in South America		74	74					74	472
All other islands and ports	244		244					244	244
Total	25, 224	155, 923	181, 147	16, 825	6, 692	39, 705	46, 397	227, 544	447, 815

TABLE XI.—*Quantities and values of the foreign fishery-products exported, by customs districts, from the United States during the year ending June 30, 1884.*

Customs districts from which exported.	Free of duty. Fish. Cod, haddock, hake, and pollock, dried, smoked, or pickled.		Herring. Dried or smoked.		Herring. Pickled.		Lobsters, canned or preserved.	Mackerel, pickled.		Salmon, pickled.		All other kinds.	Total.
	Pounds.	*Dollars.*	*Pounds.*	*Dollars.*	*Barrels.*	*Dollars.*	*Dollars.*	*Barrels.*	*Dollars.*	*Barrels.*	*Dollars.*	*Dollars.*	*Dollars.*
Boston and Charlestown, Mass	219,366	7,582	11,535	383	713	2,556	4,737	32	145	....	....	....	15,408
Brazos de Santiago, Tex	....	....	....	....	....	....	....	....	....	....	....	36	36
New York, N. Y	1,578,[illegible]	73,699	....	....	280	2,085	6,519	....	....	30	389	115,125	197,817
Portland and Falmouth, Me	....	....	....	....	....	....	7,015	....	....	....	....	....	7,015
Total	1,797,767	81,281	11,535	383	993	4,641	18,271	32	145	30	389	115,161	220,271

Customs districts from which exported.	Dutiable. Fish. Anchovies and sardines, packed in oil or otherwise.	Fish. All other kinds.	Fish. Total.	Minor and secondary products. Fish-oil and whale-oil.		Sponges.	Total.	Total.	Grand total.
	Dollars.	*Dollars.*	*Dollars.*	*Gallons.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Baltimore, Md	52	149	201	....	....	....	....	201	201
Boston and Charlestown, Mass	7,340	....	7,340	....	....	....	....	7,340	22,743
Brazos de Santiago, Tex	90	....	90	....	....	....	....	90	126
Corpus Christi, Tex	1,061	....	1,061	....	....	....	....	1,061	1,061
Huron, Mich	....	100,260	100,260	....	....	....	....	100,260	100,260
Minnesota, Minn	....	1,750	1,750	....	....	....	....	1,750	1,750
New Orleans, La	1,127	501	1,628	....	....	2	2	1,630	1,630
New York, N. Y	6,725	36,581	43,306	1,210	1,988	39,703	41,691	84,997	282,814
Paso del Norte, Tex. and New Mex	85	25	110	....	....	....	....	110	110
Portland and Falmouth, Me	....	6,218	6,218	....	....	....	....	6,218	13,233
Puget Sound, Wash	....	462	462	....	....	....	....	462	462
Saluria, Tex	136	....	136	....	....	....	....	136	136
San Diego, Cal	16	....	16	....	....	....	....	16	16
San Francisco, Cal	8,592	9,977	18,569	15,615	4,704	....	4,704	23,273	23,273
Total	25,224	155,923	181,147	16,825	6,692	39,705	46,397	227,544	447,815

TABLE XII.—*Quantities of certain kinds of domestic fish, oils, spermaceti, and whalebone exported from the United States during the eleven years ending June* 30, 1884.

Years.	Fish.		Oils.		Spermaceti.	Whalebone.
	Dried or smoked.	Pickled.	Whale and other fish.	Sperm.		
	Cwts.	*Barrels.*	*Gallons.*	*Gallons.*	*Pounds.*	*Pounds.*
1874	129, 982	29, 000	573, 775	529, 903	304, 865	114, 530
1875	129, 752	51, 025	895, 907	491, 130	238, 641	251, 572
1876	175, 528	54, 291	1, 067, 515	892, 762	141, 157	154, 500
1877	159, 648	76, 227	1, 026, 038	634, 991	153, 552	71, 708
1878	188, 831	57, 554	904, 988	723, 398	228, 276	154, 016
1879	179, 130	47, 764	2, 236, 265	812, 928	147, 503	78, 322
1880	197, 450	54, 345	1, 022, 889	482, 153	197, 847	131, 332
1881	212, 691	52, 092	597, 812	314, 568	214, 205	227, 117
1882	159, 512	38, 224	1, 083, 925	540, 064	265, 593	220, 787
1883	158, 445	48, 551	226, 983	275, 021	396, 869	326, 835
1884	221, 034	45, 034	488, 915	343, 069	259, 947*	92, 653
Total	1, 912, 003	554, 107	10,125,012	6, 069, 987	2, 548, 455	1, 823, 372

* Includes spermaceti wax.

TABLE XIII.—*Values of certain kinds of domestic fish, oils, spermaceti, and whalebone exported from the United States during the eleven years ending June* 30, 1884.

Years.	Fish.				Oils.		Spermaceti.	Whalebone.	Total.
	Fresh.	Dried and smoked.	Pickled.	Other kinds, cured.	Whale and other fish.	Sperm.			
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
1874	56, 974	612, 589	226, 041	1, 128, 208	280, 750	827, 991	78, 346	115, 098	3, 325, 997
1875	69, 448	710, 121	359, 669	1, 855, 550	413, 411	847, 014	61, 725	291, 165	4, 608, 103
1876	80, 879	900, 306	417, 281	2, 102, 522	436, 072	1, 366, 246	35, 915	215, 327	5, 554, 548
1877	114, 338	791, 785	486, 738	2, 486, 225	442, 165	879, 865	41, 027	160, 666	5, 402, 809
1878	84, 278	766, 154	416, 162	3, 198, 896	411, 808	801, 218	58, 302	264, 980	6, 001, 798
1879	80, 437	748, 747	290, 862	2, 939, 587	756, 248	719, 831	35, 489	199, 753	5, 770, 954
1880	124, 962	739, 231	284, 293	2, 326, 444	349, 109	487, 004	45, 018	255, 847	4, 611, 908
1881	97, 539	840, 199	264, 723	2, 803, 330	229, 726	303, 113	40, 945	326, 400	4, 905, 975
1882	89, 148	635, 155	244, 454	3, 218, 581	420, 730	551, 212	48, 721	325, 333	5, 533, 334
1883	72, 875	882, 830	372, 385	3, 202, 412	115, 490	290, 417	66, 651	599, 550	5, 602, 610
1884	62, 009	1, 149, 952	296, 896	2, 323, 026	190, 704	325, 385	48, 553*	319, 508	4, 716, 033
Total	932, 887	8, 777, 069	3, 659, 504	27, 584, 781	4, 046, 213	7, 399, 296	560, 692	3, 073, 627	56, 034, 069

* Includes spermaceti wax.

TABLE XIV.—*Quantities of certain kinds of foreign fish and oils exported from the United States during the eleven years ending June 30, 1884.*

Years.	Free of duty. Fish, not of American fisheries. Fresh, of all kinds.	Free of duty. Fish, not of American fisheries. Herring, pickled.	Free of duty. Fish, not of American fisheries. Mackerel, pickled.	Free of duty. Whale-oils or fish-oils, not of American fisheries.	Dutiable. Fish, not of American fisheries. Herring.	Dutiable. Fish, not of American fisheries. Mackerel.	Dutiable. Whale-oils or fish-oils, not of American fisheries.
	Pounds.	*Barrels.*	*Barrels.*	*Galls.*	*Barrels.*	*Barrels.*	*Galls.*
1874	....	233	35	....	4,271	5,334	73,429
1875	66,728	2,318	1,300	....	43	....	29,246
1876	....	2,885	885	....	....	....	52,736
1877	....	1,903	....	43,103	2	....	1,705
1878	....	21	356	379,570	....	....	8,800
1879	....	....	171	....	....	....	5,245
1880	....	....	272	....	....	....	602
1881	....	624	842	880	....	....	7,939
1882	....	101	60	10,794	....	....	11,580
1883	....	179	108	....	....	89	1,851
1884	....	993	32	....	....	....	16,825
Total	66,728	9,257	4,061	434,347	4,316	5,423	209,958

TABLE XV.—*Values of foreign fish and oils exported from the United States during the eleven years ending June 30, 1884.*

1.—FREE OF DUTY.

Years.	Fish, not of American fisheries. Fresh, of all kinds.	Fish, not of American fisheries. Herring, pickled.	Fish, not of American fisheries. Mackerel, pickled.	Fish, not of American fisheries. Sardines and anchovies preserved in oil or otherwise.	Fish, not of American fisheries. All other kinds.	Whale-oils or fish-oils, not of American fisheries.	Total.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
1874	....	1,157	358	....	29,411	....	30,926
1875	3,895	11,576	10,254	....	133,620	....	159,345
1876	....	13,305	4,515	....	39,618	....	57,438
1877	....	9,088	....	....	32,120	26,669	67,877
1878	....	71	2,279	....	76,144	217,562	296,056
1879	....	....	684	....	206,440	....	207,124
1880	....	....	1,260	....	188,265	....	189,525
1881	....	1,770	3,889	....	59,501	475	65,635
1882	....	381	360	....	53,644	4,715	59,100
1883	....	737	870	....	103,597	....	105,204
1884	....	4,641	145	....	215,485	....	220,271
Total	3,895	42,726	24,614	....	1,137,845	249,421	1,458,501

2.—DUTIABLE.

Years.	Fresh, of all kinds.	Herring, pickled.	Mackerel, pickled.	Sardines and anchovies preserved in oil or otherwise.	All other kinds.	Whale-oils or fish-oils, not of American fisheries.	Total.
1874	....	16,650	29,429	59,796	35,803	34,196	175,874
1875	....	146	....	23,296	23,433	11,236	58,111
1876	....	....	....	19,667	55,905	29,482	105,054
1877	....	22	....	24,780	135,854	794	161,450
1878	....	....	....	30,455	116,266	8,058	154,779
1879	....	....	....	29,149	54,954	2,363	86,466
1880	....	....	....	36,000	13,632	331	49,963
1881	....	....	....	45,839	69,063	3,334	118,236
1882	....	....	....	47,833	212,620	8,848	269,301
1883	....	....	719	35,113	178,874	2,136	216,842
1884	....	....	....	25,224	155,923	6,692	187,839
Total	....	16,818	30,148	377,152	1,052,327	107,470	1,583,915

TABLE XVI.—*Tonnage of the United States vessels employed in the cod, mackerel, and whale fisheries from* 1789 *to* 1884.

Period.	Whale fisheries.			Cod fisheries.			Mackerel fisheries.	Total.
	Registered vessels.	Enrolled vessels.	Total.	Enrolled vessels.	Licensed vessels (under 20 tons).	Total.		
Year ending December 31—	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1789	....	....	....	9, 062	....	9, 062	....	9, 062
1790	....	....	....	28, 348	....	28, 348	....	28, 348
1791	....	....	....	32, 542	....	32, 542	....	32, 542
1792	....	....	....	32, 062	....	32, 062	....	32, 062
1793	....	....	....	28, 974	1, 985	30, 959	....	30, 959
1794	....	4, 129	4, 129	17, 498	5, 550	23, 048	....	27, 177
1795	....	3, 163	3, 163	24, 887	6, 046	30, 933	....	34, 096
1796	....	2, 364	2, 364	28, 509	6, 453	34, 962	....	37, 326
1797	....	1, 104	1, 104	33, 406	7, 222	40, 628	....	41, 732
1798	....	763	763	35, 477	7, 269	42, 746	....	43, 509
1799	5, 055	592	5, 647	23, 933	6, 046	29, 979	....	35, 626
1800	2, 814	652	3, 466	22, 307	7, 120	29, 427	....	32, 893
1801	2, 349	736	3, 085	31, 280	8, 102	39, 382	....	42, 467
1802	2, 621	580	3, 201	32, 988	8, 534	41, 522	....	44, 723
1803	11, 247	1, 143	12, 390	43, 416	8, 396	51, 812	....	64, 202
1804	12, 016	323	12, 339	43, 088	8, 926	52, 014	....	64, 353
1805	5, 117	898	6, 015	48, 479	8, 986	57, 465	....	63, 480
1806	9, 778	729	10, 507	50, 353	8, 830	59, 183	....	69, 690
1807	8, 144	907	9, 051	60, 690	9, 616	70, 306	....	79, 357
1808	3, 802	724	4, 526	43, 598	8, 400	51, 998	....	56, 524
1809	3, 204	573	3, 777	26, 110	8, 377	34, 487	....	38, 264
1810	3, 250	339	3, 589	26, 251	8, 577	34, 828	....	38, 417
1811	5, 245	54	5, 299	34, 361	8, 873	43, 234	....	48, 533
1812	1, 988	942	2, 930	21, 822	8, 637	30, 459	....	33, 389
1813	2, 153	789	2, 942	11, 255	8, 622	19, 877	....	22, 819
1814	....	562	562	8, 863	8, 992	17, 855	....	18, 417
1815	....	1, 230	1, 230	26, 510	10, 427	36, 937	....	38, 167
1816	....	1, 168	1, 168	37, 879	10, 247	48, 126	....	49, 294
1817	4, 874	350	5, 224	53, 990	10, 817	64, 807	....	70, 031
1818	16, 135	615	16, 750	58, 552	10, 555	69, 107	....	85, 857
1819	31, 700	686	32, 386	65, 045	11, 033	76, 078	....	108, 464
1820	35, 391	1, 054	36, 445	60, 843	11, 197	72, 040	....	108, 485
1821	26, 071	1, 924	27, 995	51, 352	10, 941	62, 293	....	90, 288
1822	45, 449	3, 134	48, 583	58, 405	10, 821	69, 226	....	117, 809
1823	39, 918	585	40, 503	67, 041	11, 214	78, 255	....	118, 758
1824	33, 166	180	33, 346	68, 239	9, 208	77, 447	....	110, 793
1825	35, 379	....	35, 379	70, 626	10, 836	81, 462	....	116, 841
1826	41, 757	227	41, 984	63, 535	10, 121	73, 656	....	115, 640
1827	45, 653	339	45, 992	73, 709	10, 230	83, 939	....	129, 931
1828	54, 621	180	54, 801	74, 765	10, 922	85, 687	....	140, 488
1829	57, 284	....	57, 284	97, 889	3, 908	101, 797	....	159, 081
1830	38, 912	793	39, 705	58, 041	3, 515	61, 556	35, 973	137, 234
1831	82, 316	481	82, 797	57, 239	3, 739	60, 978	46, 211	189, 986
1832	72, 869	377	73, 246	51, 725	3, 303	55, 928	47, 428	175, 702
1833	101, 158	478	101, 636	58, 569	4, 152	62, 721	48, 726	213, 083
1834	108, 060	364	108, 424	52, 473	3, 931	56, 404	61, 082	225, 910
Year ending September 30—								
1835*	97, 649	....	97, 649	72, 374	4, 964	77, 338	64, 443	239, 430
1836	144, 681	1, 573	146, 254	58, 414	4, 893	63, 307	46, 424	255, 985
1837	127, 242	1, 895	129, 137	75, 055	5, 497	80, 552	46, 811	256, 500
1838	119, 630	5, 230	124, 860	63, 974	6, 090	70, 064	56, 649	251, 573
1839	131, 845	440	132, 285	65, 167	7, 091	72, 258	35, 984	240, 527
1840	136, 927	....	136, 927	67, 927	8, 109	76, 036	28, 269	241, 232
1841	157, 405	....	157, 405	60, 556	5, 996	66, 552	11, 321	235, 278
1842	151, 613	377	151, 990	49, 942	4, 863	54, 805	16, 097	222, 892
Year ending June 30—								
1843*	152, 375	142	152, 517	54, 901	6, 323	61, 224	11, 776	225, 517
1844	168, 294	320	168, 614	78, 179	7, 046	85, 225	16, 171	270, 010
1845	190, 696	207	190, 903	69, 826	7, 165	76, 991	21, 414	289, 308
1846	186, 980	440	187, 420	72, 516	6, 802	79, 318	36, 463	303, 201
1847	193, 859	....	193, 859	70, 178	7, 503	77, 681	31, 451	302, 991
1848	192, 180	433	192, 613	82, 652	7, 195	89, 847	43, 558	326, 018
1849	180, 186	....	180, 186	73, 882	7, 874	81, 756	42, 942	304, 884
1850	146, 017	....	146, 017	85, 646	8, 160	93, 806	58, 112	297, 935
1851	181, 644	....	181, 644	87, 476	8, 141	95, 617	50, 539	327, 800
1852	193, 798	....	193, 798	102, 659	7, 914	110, 573	72, 546	376, 917
1853	193, 203	....	193, 203	99, 990	9, 238	109, 228	59, 850	362, 281
1854	181, 901	....	181, 901	102, 194	9, 734	111, 928	35, 041	328, 870
1855	186, 778	70	186, 848	102, 928	8, 987	111, 915	21, 625	320, 388
1856	189, 213	248	189, 461	95, 816	6, 636	102, 452	29, 887	321, 800

* Nine months.

TABLE XVI.—*Tonnage of the United States vessels employed in the cod, mackerel, and whale fisheries from* 1789 *to* 1884—Continued.

Period.	Whale fisheries.			Cod fisheries.			Mackerel fisheries.	Total.
	Registered vessels.	Enrolled vessels.	Total.	Enrolled vessels.	Licensed vessels (under 20 tons).	Total.		
Year ending June 30—	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1857	195,772	70	195,842	104,573	7,295	111,868	28,328	336,038
1858	198,594	....	198,594	110,896	8,356	119,252	29,594	347,440
1859	185,728	....	185,728	120,577	9,060	129,637	27,070	342,435
1860	166,841	....	166,841	127,508	9,145	136,653	26,111	329,605
1861	145,734	....	145,734	127,311	10,535	137,846	54,795	338,375
1862	117,714	....	117,714	122,863	10,738	133,601	80,596	331,911
1863	99,228	....	99,228	106,560	10,730	117,290	51,019	267,537
1864	95,145	....	95,145	92,745	10,997	103,742	55,499	254,386
1865	84,233	6,283	90,516	59,227	5,958	65,185	41,209	196,910
1866	105,170	....	105,170	42,797	8,845	51,642	46,589	203,401
1867	52,384	....	52,384	36,709	7,858	44,567	31,498	128,449
1868	71,343	....	71,343	74,763	9,124	83,887	(*)	155,230
1869	70,202	....	70,202	55,165	7,539	62,704	....	132,906
1870	67,954	....	67,954	82,612	8,848	91,460	....	159,414
1871	61,490	....	61,490	82,902	9,963	92,865	....	154,355
1872	51,608	....	51,608	87,403	10,144	97,547	....	149,155
1873	44,755	....	44,755	99,542	9,977	109,519	....	154,274
1874	39,108	....	39,108	68,490	9,800	78,290	....	117,398
1875	38,229	....	38,229	68,703	11,504	80,207	....	118,436
1876	39,116	....	39,116	77,314	10,488	87,802	....	126,918
1877	40,593	....	40,593	79,678	11,407	91,085	....	131,678
1878	39,700	....	39,700	71,560	14,987	86,547	....	126,247
1879	40,028	....	40,028	66,543	13,342	79,885	....	119,913
1880	38,408	....	38,408	64,935	12,603	77,538	....	115,946
1881	38,551	....	38,551	66,365	9,771	76,136	....	114,687
1882	32,802	....	32,802	67,014	10,848	77,862	....	110,664
1883	32,414	....	32.414	84,322	10,716	95,038	....	127,452
1884	27,249	....	27,249	72,609	10,331	82,940	....	110,189
Total	6,773,705	53,959	6,827,664	6,019,924	777,806	6,797,730	1,549,101	15,174,495

* Included under cod fisheries since 1867.

TABLE XVII.—*Number and tonnage of vessels of the United States employed in the cod and mackerel fisheries, June* 30, 1884.

State.	Customs district in which documented.	Vessels above 20 tons.		Vessels under 20 tons.		Total.	
		No.	Tons.	No.	Tons.	No.	Tons.
Maine	Passamaquoddy	10	396.16	21	278.80	31	674.96
	Machias	8	254.48	22	275.29	30	529.77
	Frenchman's Bay	27	1,560.26	29	324.75	56	1,885.01
	Castine	33	2,209.06	27	340.28	60	2,549.34
	Bangor	1	34.23	7	97.84	8	132.07
	Belfast	32	1,664.48	34	375.11	66	2,039.59
	Waldoborough	72	2,825.69	79	984.52	151	3,810.21
	Wiscasset	33	1,838.92	38	427.42	71	2,266.34
	Bath	2	86.67	13	131.76	15	218.43
	Portland and Falmouth	104	6,129.81	38	522.73	142	6,652.54
	Saco	......	......	5	44.50	5	44.50
	Kennebunk	7	213.72	10	102.98	17	316.70
	York	......	......	3	28.38	3	28.38
New Hampshire	Portsmouth	13	492.08	8	115.18	21	607.26
Massachusetts	Newburyport	10	331.24	9	94.29	19	425.53
	Gloucester	338	22,849.61	62	747.10	400	23,596.71
	Salem and Beverly	9	669.47	16	191.43	25	860.90
	Marblehead	22	1,110.31	13	145.90	35	1,256.21
	Boston and Charlestown	56	3,121.81	8	69.51	64	3,191.32
	Plymouth	9	606.61	14	141.39	23	748.00
	Barnstable	167	13,665.46	36	412.09	203	14,077.55
	Nantucket	......	......	13	88.53	13	88.53
	Edgartown	......	......	3	18.37	3	18.37
	New Bedford	9	610.67	35	381.09	44	991.76
	Fall River	......	......	9	115.95	9	115.95

TABLE XVII.—*Number and tonnage of vessels of the United States employed in the cod and mackerel fisheries, June* 30, 1884—Continued.

State.	Customs district in which documented.	Vessels above 20 tons.		Vessels under 20 tons.		Total.	
		No.	Tons.	No.	Tons.	No.	Tons.
Rhode Island	Providence			39	320.29	39	320.29
	Bristol and Warren			3	26.76	3	26.76
	Newport	11	1,121.42	45	494.03	56	1,615.45
Connecticut	Stonington	25	1,179.29	43	437.50	68	1,616.79
	New London	32	1,410.14	33	456.10	65	1,866.24
New York	New York	20	1,643.10	113	781.66	133	2,424.76
	Sag Harbor	54	5,359.31	88	864.47	142	6,223.78
New Jersey	Little Egg Harbor	1	25.65	3	47.85	4	73.50
Maryland	Baltimore	16	540.33			16	540.33
Virginia	Tappahannock	4	128.68	25	256.18	29	384.86
	Cherrystone	1	22.26	4	56.19	5	78.45
North Carolina	Beaufort	3	78.09	3	34.05	6	112.14
Florida	Pensacola	9	368.39	4	46.14	13	414.53
Alabama	Mobile	2	61.96			2	61.96
California	San Diego			5	49.27	5	49.27
	San Francisco			1	5.27	1	5.27

SUMMARY.

State.		Vessels above 20 tons. No.	Tons.	Vessels under 20 tons. No.	Tons.	Total. No.	Tons.
Maine		329	17,213.48	326	3,934.36	655	21,147.84
New Hampshire		13	492.08	8	115.18	21	607.26
Massachusetts		620	42,965.18	218	2,405.65	838	45,370.83
Rhode Island		11	1,121.42	87	841.08	98	1,962.50
Connecticut		57	2,589.43	76	893.60	133	3,483.03
New York		74	7,002.41	201	1,646.13	275	8,648.54
New Jersey		1	25.65	3	47.85	4	73.50
Maryland		16	540.33			16	540.33
Virginia		5	150.94	29	312.37	34	463.31
North Carolina		3	78.09	3	34.05	6	112.14
Florida		9	368.39	4	46.14	13	414.53
Alabama		2	61.96			2	61.96
California				6	54.54	6	54.54
Total		1,140	72,609.36	961	10,330.95	2,101	82,940.31

TABLE XVIII.—*Number and tonnage of vessels of the United States employed in the whale fisheries, June* 30, 1884.

State.	Customs district in which documented.	Number.	Tons.
Massachusetts	Boston	3	286.26
	Barnstable	11	1,023.43
	Edgartown	6	998.33
	New Bedford (sail)	93	23,450.21
	New Bedford (steam)	2	790.27
Connecticut	New London	6	700.44
Total		121	27,248.94

XIX.—GILL-NETS IN THE COD FISHERY: A DESCRIPTION OF NORWEGIAN COD-NETS, ETC., AND A HISTORY OF THEIR USE IN THE UNITED STATES.*

By Capt. J. W. COLLINS.

CONSTRUCTION AND RIG OF THE NETS.

1.—NORWEGIAN METHODS.

The nets used in the Norwegian cod fisheries are usually made of hemp twine, of two, three, or four threads, but occasionally of flax or cotton. The three-laid hemp twine, which is the most common size, weighs a pound to 400 or 420 fathoms. It is made chiefly on spinning-wheels by the fishermen's families, and the nets are constructed almost exclusively by the fishermen and their wives and children. Some of the hemp twine, however, is furnished by the factories of Norway and Great Britain, which also supply all of the cotton and linen twine.

The size of the mesh varies somewhat, according to the locality where the nets are to be used, as it is necessary to make the mesh correspond to the size of the fish that frequent different parts of the coast or make their appearance at different seasons. The smallest mesh is about $5\frac{2}{3}$ inches ($2\frac{7}{10}$ inches square) and the largest 8 inches (4 inches square). Those exhibited at Berlin were 7 and 8 inch mesh.

The length of the nets varies from 10 to 20 fathoms, the average length of those used at the Loffoden Islands being $15\frac{1}{4}$ fathoms when hung, and they are from twenty-five to sixty meshes deep. Nets about thirty meshes deep are generally used, while those of sixty meshes are employed only where there is little or no current. The nets are hung both to single and double lines, and these vary somewhat in size. Those exhibited were hung to double lines, each being $\frac{7}{10}$ of an inch in circumference, while Mr. F. M. Wallem says that 2-inch rope when single, and 1-inch rope when double, is the size commonly used at the Loffoden Islands. Some of the nets are hung to lines only at the top and bottom, having none across the end, while others have them on the ends as elsewhere. This last method is said to have been recently introduced, and is considered an improvement when the line is a little short, so that the

*Revised and republished from volume 1, Bulletin of the United States Fish Commission, 1881, pp. 1–17, with an account of the results subsequently obtained in the United States.

net will be a trifle slack or baggy. About one-third of the net is taken up in hanging; that is, if a net is 30 fathoms long stretched out before it is hung, it will be about 20 fathoms long afterwards. They are hung with twine about the same size as that of which they are made. The end of the twine is first made fast to the hanging line, then hitched to the upper part of one of the meshes, the distance between the line and mesh being equal to one side of the mesh; then back to the line again, around which a clove-hitch is taken, thus forming one-half of a mesh, as shown in Plate I. This method of hanging is thought by the Norwegian fishermen to be superior to any other for large-mesh nets. The twine or net webbing is generally prepared for use in Norway by tanning, and will last, when so prepared, from one to five seasons.

The nets are supported upright in the water by floats of wood, cork, or hollow glass. At the Loffoden Islands, where nets are more extensively used than elsewhere, the glass floats are preferred, it being said that they replace to great advantage the old wooden ones, which failed to prevent the nets from settling on the bottom. The fishermen from Söndmör, however, who fish on banks where there is a strong current, prefer wooden to glass floats, since it is said the latter are so much more liable to be carried away by the tide, causing the loss of many nets; while the principal objection to wooden floats is that they are so easily water-logged. But the latter is thought to be the less evil of the two by the Söndmör fishermen, since the floats can at the worst only sink to the bottom with the nets, whence they may easily be recovered. From this experience of the Norwegian fishermen, it may be inferred that while glass floats are preferable for general use, they are not so suitable as either wood or cork buoys where there is a strong tide. The glass floats are about 5 inches in diameter, with a covering of tarred marline or spun-yarn hitched over them, to which is attached an eye. In this eye is bent the small rope that holds them to the net. When so prepared for use these floats are quite strong, and break far less frequently than might be supposed. They withstand the pressure of water when submerged better than anything that has been tried, but are sometimes filled with water—"drunken," it is called—when set in depths of 75 fathoms or more. Plate II is intended to show the glass float and the way in which it is attached to the net. The small ropes with which these are held vary in length from 1½ to 6 feet.

Oblong shaped stones, from 3 to 5 inches in length, are used for sinkers. By experience the fishermen learn how large these should be to sink the nets to the desired depth. From ten to twelve are fastened to the bottom of the net at equal distances apart, being held in a double string, as shown in Plate III.

Large stones are used instead of anchors to hold the nets to the bottom. These weigh from 72 to 144 pounds, the heavier one heading the current, and the smaller being on the other end of the gang, containing twenty to thirty-five nets. Besides these "mooring rocks," there are

others of smaller size that are held to the nets by a foot-line, one end of which is fastened to the stone which lies on the bottom, and the other to the rope that connects the lower corners of the nets together. The larger stones are generally slung with rope, but sometimes there is a band of iron around them with an eye or ring, to which the foot-line can be fastened. Iron anchors are not used, as the nets are liable to be torn on them should they settle on the bottom. Plates VI and VII show how the mooring rocks and the other stones are attached to the nets.

Buoys of different kinds are used by the Norwegian fishermen, but, according to Mr. Wallem, at the Loffoden Islands glass buoys, having a capacity of from three to five gallons, are the most common. These are generally egg-shaped and are covered in the same manner as the glass floats. Sometimes a buoy is made by fastening several of the latter around a staff, as shown in Plate X. The glass buoys of both kinds are employed in the trawl as well as the net fishery; they will rise to the surface again after having been under water for several days, an advantage not possessed by other kinds, and it seems that buoys of this description might be profitably used by our bank-fishermen, who frequently lose large quantities of gear on account of the wooden-keg buoys bursting and filling with water when they are submerged to any considerable depth. Hard-wood iron-bound kegs are used by some of the Norwegian net fishermen. From two to four glass floats, such as are on the nets, are fastened to the bight of the buoy-line, at different distances from the buoy, for the purpose of keeping the slack or scope from going on the bottom when there is no current. Where there is a strong tide, and a probability of the large buoy being drawn under the surface of the water, a number of the glass balls are attached to it with a line, these serving as "watch buoys" for the other. Plate V shows how the glass floats are fastened to the buoy-line and buoy.

2.—Newfoundland methods.

The nets employed in the Newfoundland cod fisheries are usually made of hemp twine one size smaller than salmon twine, which is also occasionally used. The size of the mesh is generally about 6 inches (3 inches square), a large mesh not being required for the small fish that generally frequent that coast. The nets vary in length from 50 to 80 fathoms, and in depth from 3 to 4 fathoms. They are hung to the lines in the same way that the Norwegian nets are, the foot-line being 1¼ inch rope, while small-sized double lines, of opposite lays, are the hangings for the top and ends. Rope is used on the lower part of the net, because, when set close to the bottom, small line would probably be bit off by ground-sharks, thereby causing the loss of a portion of the net.

To preserve the nets the Newfoundland fishermen make a mixture of tan and tar, which is thought better than either used separately. The tan is commonly made from spruce buds, fir bark, and birch bark (hem-

lock bark is not used), which are boiled together until it is sufficiently strong, when the bark is removed, and tar added in the proportion of five gallons of tar to two hundred gallons of tan, the whole being stirred well together. Some care is necessary in applying this, or else it will not be evenly distributed on the net. The custom of mixing tan and tar has doubtless been introduced from England, as it is known that the Cornish fishermen do this, pouring out their tanning liquor into large vats with coal-tar, and this mixture is found to preserve the nets much longer than simple tanning. The Newfoundland nets, when prepared in this manner, generally last about 4 seasons.

The floats are made of the best bottle-cork, when obtainable. Before being used they are dipped in hot pitch or tar, after which it is said they will stand for 4 weeks at the bottom in 50 fathoms before getting water-soaked. The fishermen have two sets of floats—one, when soaked, being replaced by the other.

The sinkers most generally in use by the Newfoundland fishermen are made by tying small rocks in a bag of old netting or cloth; but lead sinkers, similar to those on seines, are occasionally attached to the nets. The sinkers weigh from 1 to 2 pounds, are about 13 feet apart, and are fastened close to the bottom of the net.

Anchors, rocks, and stone killicks are used for moorings to the nets. The former weigh from 20 to 25 pounds each, while the killicks and rocks vary from 25 to 60 pounds, the heavier heading the current, and the lighter being on the opposite end of the net or gang.

The buoys are generally made of dry fir poles, 6 to 8 inches in diameter, which are usually from 3 to 4 feet long, and sharpened at one end, through which is a hole for the strap which the buoy-line bends to. Kegs are also used for buoys.

3.—American methods.

The nets that were first tried in Ipswich Bay were made of twine about the same size as that used in Norway; indeed, part of them were Norwegian nets which had been lent to Capt. George H. Martin by the United States Fish Commission. These were found, as in the previous trials made by the Commission, entirely too weak for the purpose, and were soon badly torn, not, however, before it had been proved that suitable nets could be very successfully used. The nets which have since been constructed for this fishery are made of Scotch flax twine, twelve-thread, of the size represented in Plate IV. The twine is very strong, and is found to be well adapted for the capture of large cod. The nets are mostly 9-inch mesh ($4\frac{1}{2}$ inches square), that size having been found well adapted for taking the large cod that visit our coast in winter.

The size of the nets depends somewhat on the locality where they are used, and also on the movements or habits of the fish. In some places where the cod keep close to the bottom, long shallow nets are probably the most suitable, while at other points, as at the Loffoden

Islands, where fish are often found in the greatest numbers some distance from the bottom, deeper nets are required.

The nets made for Captain Martin in the winter of 1880–'81 were 50 fathoms long and 3 fathoms deep, but as nearly all the fish were caught near the bottom, other persons have since had longer nets of less depth; some of those made for the shore fleet have been 100 fathoms long and 2 deep, but the standard size seems to be about 50 fathoms in length and $2\frac{1}{2}$ to 3 fathoms in depth.* The American nets are hung to small double lines of opposite lays, and they are tanned before being used. It may be well to mention here the Dutch method of tanning cotton herring-nets, which is thought better than any other by those foreign fishermen, and may, perhaps, be applied with equal advantage to other nets, when made of that material. The tan is made by boiling catechu in water in the proportion of one pound of the former to two and a half gallons of the latter. When it is sufficiently strong the nets are soaked in it for twenty-four hours, after which they are dried. They are tanned and dried three times, and then soaked in linseed oil. A pound of oil is provided for each pound of net, and they are allowed to remain in it as long as any will be absorbed. They are then well drained and spread out on the ground to dry, after which the process is completed by tanning them once more.

Glass floats, similar to those of Norway, have been used on the American nets.† These cost about 30 cents each, when covered, and twenty-five of them are attached to a 50-fathom net. Bricks are used for sinkers, one of which is fastened to the foot of the net directly beneath each of the floats, they being held in the same manner that the stone sinkers are, as shown in Plate III. Attempts have been made to use metal sinkers and also metal floats, but these have proved unsatisfactory, and no improvement has yet been made on the brick sinkers first adopted. The cost of nets 50 fathoms long, with floats attached, is about $18.

Fourteen-pound trawl-anchors have been found quite suitable for Ipswich Bay, one being attached to each end of a gang of three nets, but it is probable that heavier ones will be required where there is deeper water and more current.

The buoys are common quarter-barrels, rigged in the same manner as for trawling.

THE FISHERIES.

1.—The Norwegian fisheries.

The method of taking cod with gill-nets is said to have been introduced into Norway about 1685, and nets are now extensively employed at the principal fishing stations along the coast of that country, but more than anywhere else in the great winter cod fisheries that are car-

* These nets have been made principally by the American Net and Twine Company, and by H. & G. W. Lord, Boston, Mass.

† These are made at the glass factories in Boston.

ried on at the Loffoden Islands. These islands are situated on the west coast of Norway, north of the arctic circle, and the banks in their vicinity are the favorite resort of immense schools of cod that gather there to spawn. Toward the latter part of December the first schools appear upon the grounds along the outer side of the Loffoden group, and soon the "coming-in" fish are taken on those banks lying inside, in the West Fiord. The arrival of these fish, which are the forerunners of the countless millions that invariably follow, is hailed with great delight by the fishermen, many of whom resort hither from other parts of the country to engage in these fisheries, so many often being congregated here in the winter that at some points they are crowded.

The bank which is the principal resort of the fishermen from Nordland extends along the coast of Loffoden from the Roost Island to the Strait of Rafte. This is from three to twelve miles from the land, and has a depth varying from 40 to 80 fathoms.

The fishing is at its height in February and March, while the fish are spawning. At this period, especially during the latter month, the cod are said to be very restless and disinclined to take the hook, and are usually caught in nets, the catch being increased and a better quality of fish obtained by using them. The experience of the Norwegian fishermen shows that the fatter the fish the less it is inclined to take the bait; therefore the most skilful fishermen are provided with nets as well as trawls.

The fishing is carried on in open boats. The net boats, which, as a rule, are larger than those used for trawling, are from 35 to 40 feet long, 9 or 10 feet wide, and 3 feet deep. These are provided with a single mast, on which is set a large quadrangular sail, and each boat has also ten or twelve oars, by means of which the crew can row rapidly even against the wind. The crew of a boat fitted for the net fishery varies from six to eight men, and the number of nets from sixty to a hundred. These are not all in use at the same time, but the greater part are kept in reserve to supply the place of such as may need repairs or drying or which may be lost. From twenty to thirty-five nets are fastened together and set in a gang by each boat on a specified part of the fishing ground. Where so many are fishing at one place they are obliged to adopt some rule for setting the gear to prevent its fouling, since that would result in loss to all and soon render a valuable fishery practically worthless. A certain part of the fishing ground is therefore assigned for the nets and another part for the trawls, as it is evident they should not be set together. The nets are prepared for setting by fastening them together at the top and bottom, attaching the sinkers, and bending on the large anchor-stones in the manner already alluded to, which is shown in Plates V, VI, and VII. The nets are so arranged that they will set close to the bottom or at some distance above it, according to the position of the fish.

The cod in the vicinity of the Loffoden Islands are said to be somewhat erratic in their movements, and it frequently happens that they are found in the greatest numbers at some distance from the bottom. The fishermen place their nets at a depth where they think the fish are most plentiful, and several expedients are made use of in order to find this out, such as trying with a hand-line, and setting a gang of nets with one end at the bottom and the other some distance from it, as represented in Plate VI.

Nets are occasionally set floating, but this method is practiced but little except at the stations east of Sorvaagen. One experienced in fishing soon learns at what depth the largest number of fish can be taken, and places his apparatus accordingly.

The fishermen all start in the afternoon at a given signal to set their gear, both nets and trawls being thrown out simultaneously to prevent them from becoming tangled, though this is sometimes unavoidable on account of the strong winds and tides. The nets are shot across or with the current. As soon as they are out the boats return to the shore.*

At the Loffoden Islands the fishermen start out together in the morning to haul their nets. In the darkness of the long nights they enter their boats; for the brief daytime, often shortened by gloomy skies, would be far too short for the work which has to be accomplished. They regard neither cold nor storm so long as the waves are not too high, so as to make fishing impossible. Hauling the heavily weighted nets, sometimes from a depth of 80 to 100 fathoms, is a task requiring the united strength of the boat's crew. The nets are hauled into the boats and taken on shore, where they are cleaned and put in readiness to be set again. But it must be remembered that in this region stormy weather often continues for weeks at a time during the winter months, making it impossible for the fishermen to go out to the banks, and as a rule fishing cannot be carried on more than two days in the week.

The daily fishing varies from a few scattering cod to several hundreds. A catch of four to five hundred to a boat is considered very satisfactory, although six hundred are often taken when everything is favorable, even when they will not bite and hand lines or trawl lines cannot be used. If more than six or eight hundred are caught, the fishermen are obliged to leave a part of the nets out until afternoon, as the boats can rarely carry any more, especially in rough weather.

The total catch of cod at the Loffoden Islands in 1878, according to the report of the superintendent, was 24,660,000 in number. Of these, upward of 14,000,000 fish were caught with nets, 9,250,000 with lines,

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*At Söndmör, where the banks lie some distance from the coast, the fishermen sometimes stay out overnight during the month of April, when the nights have already become clear. Usually, however, these men haul their nets and return them again to the water, while they start for the shore to dispose of their catch.

and 1,250,000 with deep bait.* The men and boats engaged were divided as follows:

Method of fishing.	Fishermen.	Crews.	Boats.
Net fishing	13,168	2,154	*2,430
Line fishing	7,258	1,689	1,977
Deep-bait fishing	2,297	844	†844
Hired men	3,311		
Total	23,034	4,687	5,251

* 269 of these also occasionally used lines. † 701 of these used no lines, and 143 used lines.

There was an *increase* from the year before of 2,542 in the number of net fishermen, an *increase* of 417 in the number of deep-bait fishermen, and a *decrease* of 1,504 in the number of line fishermen.

Highest total sum earned by net fisherman	$214 40
Lowest total sum earned by net fisherman	48 24
Highest total sum earned by line fisherman	120 60
Lowest total sum earned by line fisherman	32 16
Highest total sum earned by deep-bait fisherman	85 76
Lowest total sum earned by deep-bait fisherman	42 88

The superiority of the nets over lines and trawls, as shown by the respective earnings of the fishermen, has, as might be expected, led to an additional increase in that branch of the fishery, and in 1879 it is stated that 2,532 boats, with crews numbering 14,322 men, fitted out for the net fishery. The larger amount earned by the net fishermen is due to the better quality of fish taken by them more than to the increased catch, though this is also generally obtained. It has been found that the largest and fattest cod do not bite at the hook, but must be sought after with gill-nets, and it therefore follows that netted fish furnish a very superior article of merchandise.† It sometimes requires but 210 cod caught in a net against 360 taken on a hook to furnish the same amount of liver (about 26½ gallons), and the livers of the netted fish yield much more oil to the gallon than those of the trawl or line fish. In conclusion, it may be added that pollock are taken in gill-nets as well as cod. During the winter season large schools of these fish visit the coast between the sixtieth and sixty-second parallels of latitude, and in the summer and fall are found on the coasts of Nordland and Finmark, where enormous quantities of them are taken by nets, trawls, and hand-lines.

2.—The Newfoundland fisheries.

Gill-nets have long been used in the Newfoundland cod fisheries, especially on the east and south coasts of the island, but the exact date

* Trawls are probably meant by lines, and hand-lines by deep bait.

† The same fact has been demonstrated by the use of nets on the American coast. Both cod and pollock, of large size and extra quality, are frequently taken in abundance by nets when few or none can be caught on hooks and lines.

of their introduction is unknown. It is asserted, however, that this method of fishing has been pursued since early in the present century, and is still carried on to some extent.

The coast of Newfoundland is indented with many large bays, which are favorite feeding-grounds for the cod. In the early summer they make their appearance in pursuit of the capelin that gather in immense numbers along the shores to spawn, and generally remain from three to five weeks. During this time the cod usually keep near the surface of the water and the nets are set floating, but later they are set at the bottom, for when the capelin leave the shores the cod move into deeper water. Plates VIII and IX show the methods of setting at the surface and bottom. The nets are set singly or in gangs of three to seven. Two anchors are generally attached to a gang of floating nets, as represented in the plate; but where there is a current, one is sometimes found sufficient. They are usually set in the afternoon and hauled in the morning. Owing to the comparative lightness of the anchors, fewer men are required to haul these than in Norway, as a single fisherman will sometimes take in one or more nets, though in most cases two or three go in a boat. The net fishing is far less productive than that of Norway, but sometimes a large catch is made. Capt. Solomon Jacobs, a native of Newfoundland, states that on one occasion he took 2,000 cod from four nets, but says that this catch is rarely equaled. These fish are what are known in the American markets as medium cod.

3.—The American fisheries.

The common dory has been used for fishing the nets, each vessel having from seven to nine of them, according to the number of the crew. The men go singly, one in each dory, and, while out, either setting or underrunning, the vessel is kept under way, the captain and cook managing her and picking up the crew when the work is completed. Each one of a schooner's crew, except the captain and cook, is provided with a gang of three nets or more, which are fastened together at top and bottom when set, these forming a wall at the bottom of the sea 150 to 300 fathoms long and 3 fathoms deep, being held in position by an anchor at either end. The anchor-lines are usually 50 fathoms in length, and one end of each is bent to the upper corner of the nets, as represented in Plate XI. Under favorable circumstances one man can set a gang of nets, by letting the boat drift with the wind or tide and throwing them over as it moves along, but, as a rule, two men can accomplish this much better. The method of underrunning is illustrated in Plate XII.

4.—History of the gill-net cod fishery.

The United States Fish Commission, while it has in so many ways done a useful and important work in the artificial propagation of food-fishes, has not confined itself solely to fish-culture as a means for improving the American fisheries. It has also accomplished fully as important objects by disseminating among our fishermen knowledge of

methods of fishing, &c., to which they were previously strangers, and which has been of the utmost advantage to them for the successful prosecution of their work. The introduction of the use of gill-nets in the cod fisheries may be mentioned as an instance in point, and viewed in the light of results already attained (though we may yet consider this method of fishing only fairly begun), it seems not too much to claim that the bringing about of such an innovation in the ocean fisheries is entitled to rank among the most important works of the Commission. The change which has been made in the method of taking cod and other species of the *Gadidæ* has proved of such immense advantage to the New England fishermen that an entire revolution has been created in the winter shore cod fishery, and it is difficult to predict to how great an extent the gill-net fishery for cod may be prosecuted in the future. It is not now possible to say with any degree of certainty whether or not gill-nets may be successfully employed in the cod fisheries of the outer banks, since a thorough and careful trial needs to be made to settle that question. A few unsatisfactory attempts have already been made by the fishermen to use gill-nets on the outer banks, but in no case have these trials been so extensive and thorough as to demonstrate fully what might or might not be done. In consideration of the results which have already been attained, it seems desirable that a brief historical sketch should be given here of the introduction of gill-nets into the cod fisheries of the United States, and also of the varying success which has attended their use since they were first adopted by American fishermen.

Though gill-nets have long been used in Northern Europe, more especially in Norway, as an apparatus for the capture of cod, and are considered by the Norwegians as quite indispensable, they have not, until recently, been employed by American fishermen. In 1878 Prof. Spencer F. Baird, United States Commissioner of Fish and Fisheries, knowing how profitably these nets were employed by the Norwegian fishermen, decided to make experiments with them at Cape Ann, with a view to their introduction among the fishermen of this country. He accordingly secured a number of the Norwegian nets, which were forwarded to Gloucester and there tested by the employés of the Commission.

Experiments were made when the winter schools of cod were on the shore-grounds in Massachusetts Bay; but the results obtained were not entirely satisfactory, owing chiefly to the fact that the nets were found far too frail for the large cod which frequent our coast in winter. This was apparent from the numerous holes in the nets, which indicated plainly that large fish had torn their way through, none being retained excepting those that had become completely rolled up in the twine. The current also swept the nets afoul of the rocky bottom, which injured them still more, so that they were soon rendered nearly unfit for use. They were invariably in bad order when hauled from the water, but

even under such unfavorable circumstances nearly a thousand pounds of fish were caught on one occasion. This seemed to indicate that nets of sufficient strength might be used to good advantage, at least on some of the smoother fishing grounds along the coast.

These preliminary trials, therefore, having demonstrated that nets could be employed advantageously in the American cod fisheries, Professor Baird availed himself of the first chance that offered for obtaining definite knowledge of the methods of netting cod in Norway, with the intention of disseminating this information among American cod fishermen.

The opening of the International Fishery Exposition at Berlin, Germany, in the spring of 1880, presented a favorable opportunity for accomplishing this purpose. Professor Baird, having appointed me as one of the Commission to attend the exposition on the staff of Prof. G. Brown Goode, desired that I should make a careful study of the foreign methods of deep-sea fishery as represented at the exhibition. The method of capturing cod with gill-nets, as practiced by the Norwegian fishermen, was mentioned as a subject which should receive especial consideration.

In the meantime Professor Baird offered to lend the nets to any responsible fishermen who would give them a fair and thorough test. But the fishermen were conservative and hesitated to adopt any "new-fangled notions" for catching fish. This disinclination to try the new method was due chiefly to the fact that fishermen cannot usually afford to spend any time in making experiments, especially when they feel fairly confident of good returns by continuing in their old ways of fishing.

Mention has been made of the introduction and trial of cod gill-nets by the United States Fish Commission in 1878, but no attempt was made by the fishermen to use them until the fall of 1880, when Capt. George H. Martin, of Gloucester, Mass., master of the schooner Northern Eagle, fitted out with them for the winter cod fisheries off Cape Ann and in Ipswich Bay. The immediate cause which led to this trial was the difficulty of getting a supply of bait, the procuring of which is a source of considerable trouble to our shore fishermen, and its cost, even when obtainable, is such a heavy tax on this branch of the fishing industry that often the fishermen hesitate to engage in it, fearing that the result may be a loss rather than a gain. It was to obviate this difficulty about bait, and to render our cod fisheries more valuable in consequence, that led Professor Baird to bring the cod gill-nets to the notice of the American fishermen. The bait principally depended on by the shore fishermen in the vicinity of Cape Ann during the fall and early winter is young herring (*Clupea harengus*), known as the "spirling." The appearance of these fish about the cape is somewhat uncertain; sometimes large schools remain for several weeks, and at other times but few can be taken. There was so little probability of getting a supply of bait in the

fall of 1880 that Captain Martin hesitated about fitting out for trawling, fearing that the cost and difficulty of securing a supply of this article, which is indispensable to the trawl-line fishery, would render the undertaking unprofitable. While the matter of fitting out in the old way was under consideration gill-nets were suggested by the father of Captain Martin, an employé of the Fish Commission, as a means of solving the perplexities of the bait question. He thought the idea a good one, and, together with several of his crew, visited the station of the Commission at Gloucester, looked at the Norwegian nets which were there, and consulted with the agent in charge as to the probabilities of success. The result of this interview was that Captain Martin decided to fit out and give the new method a thorough trial, and nets were therefore obtained for this purpose, part of them being supplied by the Fish Commission.

Before the trial trip was made Captain Martin had an interview with me at Gloucester in order to get some additional information as to the management of the nets. I explained to him briefly the methods adapted by the Norwegians. He thought, however, that the nets might be "underrun," as trawls sometimes are, which would enable one man to handle a gang of nets for which an entire boat's crew, six to eight men, is required in Norway. I could see no reason myself why the nets could not be underrun, providing the current was not too strong and the water not too deep. It may be explained here that the Norwegians set their nets late in the day and take them up on the following morning, the apparatus being carried to the land, the fish removed from the meshes, and the gear prepared for setting again. This involves a large amount of labor and much loss of time as compared with the method of underrunning, which may be considered another Yankee invention.

When the nets are set for underrunning, the anchor is first thrown over and 25 fathoms of line paid out, when the buoy-line is attached to it. The buoy and line are then thrown over, and the remainder of the anchor-line is then paid out, the end of the latter being made fast to the nets, which are the next to follow. A middle buoy is attached to the center of the gang. When the nets are all out, the other anchor-line, with the buoy-line attached, is veered out, and last of all the anchor is thrown over, which finishes the work. The nets are usually set in the afternoon, and allowed to remain in the water for several days, unless for some reason the vessel leaves the fishing ground. Even then, when the vessels have been forced to seek the shelter of a harbor during a storm, the nets have frequently been left out. Fish are caught only at night, and, consequently, the nets are underrun only in the morning, unless the men are detained by unfavorable weather until later in the day. In underruning, the fisherman goes to one of the buoys on the end of his gang of nets, takes it in the dory, and hauls away on the buoy-line, the buoy being thrown out on the other side, and the line allowed to run out on one side as fast as it is hauled in on the other.

When the anchor-line (or underrunning-line, as it is sometimes called) is up, it is taken across the dory, and the fisherman hauls along towards the net. The gear is underrun by pulling the nets in on one side of the dory, and, as fast as the fish are removed, allowing the apparatus to pass over the other side into the water; the anchors, which remain firmly fixed in the bottom, holding the nets in position until the work is accomplished. When the end of the gang is reached, it is thrown off the dory, and the nets remain setting as before, needing no further attention until the next day.

As will be readily understood, this method of fishing can be carried on with the minimum of labor; and it also has this additional advantage, namely, while the gear is still out, the vessel may take her morning's catch to market, or, if the weather is threatening, she may remain quietly at anchor overnight in the nearest harbor, though in the meantime her nets are fishing.

Ipswich Bay, where the nets have been chiefly used, more particularly in the winters of 1880–'81 and 1881–'82, lies north of the prominent headland of Cape Ann, which divides it from the waters of Massachusetts Bay on the south. A sandy beach extends along the northern and western sides of the bay, and the bottom sinks gradually from this, reaching a depth of 25 to 30 fathoms only at a distance of several miles from the land. The bottom of the bay is a sloping sandy plateau, with only here and there small patches of rocks or clay, supporting but a small amount of animal life which may serve as food for the cod. It is therefore a spawning rather than a feeding ground for these fish; and large schools visit the bay during the winter for the purpose of reproduction, and generally remain until late in the spring. The nets are usually set along the northern part of the bay, only a few miles from the shore, in about 15 fathoms of water, where there is less current than at many other points along the coast.

In this connection may be mentioned a curious fact which has been observed concerning the fish that have been taken in Ipswich Bay during the past two or three winters. It is stated that a large portion of the fish caught in this bay have been netted on a small area not exceeding three-fourths of a mile in diameter. This piece of ground, I have been told by the fishermen, for a considerable portion of the season seems to be swarming with cod, while the adjacent bottom appears to be quite barren of fish. According to Capt. S. J. Martin, the center of this area bears south by west from Whale's Back light, Portsmouth, and southwest by west from the light-house on the Isle of Shoals. It is somewhat irregular in outline, the fishermen say, judging by where the fish are taken, but so far as anything can be told of its physical conformation, it does not differ at all from the rest of the sandy slope immediately surrounding it. It is said that there is no "feed" on the bottom. The fishermen have a curious theory that there are freshwater springs in this particular locality, around which the cod love to gather;

nor, indeed, can they assign any other reason, since there appears to be no special feature in the character of the bottom to attract the fish. So persistent are the cod in clinging to this locality, that it almost invariably follows that nets placed within its limits come up well filled with fish, while gear that is set a dozen or twenty fathoms outside get very few, if any, cod. The fishermen confess that it is a mystery to them, and they are exceedingly puzzled to know how the fish get there and escape the walls of netting which surround this spot in all directions. They do not believe it is possible that enough cod could be there at once to fill the nets night after night for months, and they arrive at the conclusion that the fish must reach the place during the day, at which time they are supposed to rise above and swim over the nets that bar their progress near the bottom, and which of course can be seen by daylight.*

The results which were obtained from the use of nets by the Northern Eagle during the winter of 1880–'81 were considered very remarkable. The amount of codfish taken in the first three trials (which were made in Massachusetts Bay), in unfavorable weather and with inferior nets, was 4,000, 6,000, and 7,000 pounds, respectively. On a trip ending January 11, 35,000 pounds of cod were taken by the Northern Eagle, 8,000 pounds of which were caught in a single morning. Two other vessels, which were absent the same length of time, fishing at the same place with trawls, got only 4,000 and 8,000 pounds, respectively. After that time she made another trip, taking the same amount, 35,000 pounds, in four days' fishing, 18,000 pounds of which were caught in one day. On this day the schooner Christie Campbell, of Portsmouth, set ten trawls (each trawl having 1,000 hooks) close to the nets. The 10,000 hooks caught about 2,000 pounds of fish to the 18,000 taken in the nets.

The Northern Eagle began fishing with nets on November 27, 1880, and as early as January 20, 1881, she had taken 111,000 pounds of cod. None of the trawlers during that time caught more than one-third of that amount, though they were fishing at the same place. The netted fish were much larger than those taken on trawls, averaging during the first six weeks' fishing 23 pounds each. Among these were individuals which weighed 75 and 80 pounds apiece, but there were no small fish, such as are frequently taken on trawls, and which can be sold only at reduced prices. This, it may be stated, has invariably been the case when gill-nets have been used. No immature fish, or what is termed "trash" by fishermen, have been taken. At first the nets met with the same opposition from the trawl-line fishermen that trawls, when first

* Capt. S. J. Martin, writing from Gloucester to Professor Baird, under date of January 7, 1884, says: "In Ipswich Bay the fish are in one place. Four hundred nets are set in a place one-half mile wide by one-half mile long. The nets are across one another. The vessels have set their nets all over the bay, but find only a few scattering fish except in that one spot. There they get good hauls every morning when there is a chance to haul the nets. * * * The fishermen think strangely of the fish being in one place. They can find nothing there to keep them alive."

introduced, did from the hand-liners, some thirty years ago. Notwithstanding, however, that many of the fishermen were inclined at the start to inveigh against "building a fence" to prevent the fish from moving about on the bottom, it was not long before they all began to realize the advantages of using gill-nets. It is said that whenever in port the deck of the Northern Eagle was crowded with fishermen anxious to learn about the method of capture which she had adopted. Before the close of the first winter several vessels, both from Gloucester and from other ports, fitted out, to a greater or less extent, with nets. As a rule those schooners commenced their operations so late in the season that they could not make a fair test of the gill-nets, for the school of spawning fish that had been in Ipswich Bay began to leave the shore-grounds soon after the vessels began operations.

Gill-net fishing for cod and pollock opened favorably in the winter of 1882, but the shore codfish were much less abundant during the greater part of that winter than in the previous year; and consequently the success of this branch of the fisheries was not so pronounced as has generally been the case.

Writing under date of November 15, 1881, Captain Martin says: "I find that pollock will mesh as well as codfish. The first night the schooner Maud Gertrude set her nets, twelve in number, they caught 3,000 pounds of pollock and 2,000 pounds of cod. The nets were set on 'Browns.' [This is a small rocky shoal lying off to the southward of Eastern Point, at the entrance to Gloucester Harbor.] * * * Captain Gill told me that if the nets had 8-inch meshes they could get them full of pollock. The 10-inch mesh catches large pollock, some of them weighing 20, 21, and 21½ pounds." The nets were often very badly torn by the pollock, which is well known to be a remarkably strong and active fish.

It does not seem necessary that I should go into detailed statements of statistics of the amount taken each season, since the following instances that are given of catches made on various occasions will, I think, serve to convey a fair idea of the results obtained.

Although the winter of 1881–'82 was unquestionably the least productive of any season since the introduction of gill-nets into the shore cod fishery, we find that the catches were often of considerable magnitude. For instance, Captain Martin mentions the following facts: Early in November twelve nets set in Ipswich Bay caught 12,000 pounds of cod in two nights' fishing. A little later the Northern Eagle landed 33,000 pounds of large cod from an eight days' trip, stocking $800, and each of her crew sharing $63. Captain Martin, writing under date of December 6, said that during the previous week there were 145,000 pounds of codfish caught in gill-nets, and he makes this remark, "If it were not for the gill-nets we could not get fish enough to eat." He also says, "All the vessels that were fishing with trawls are getting nets." Again, on December 22, he states, "There were 165,000 pounds of

codfish caught in gill-nets last week." This, too, was when codfish were remarkably scarce upon the shore-grounds, and when there was only a small fleet of about 25 or 30 vessels engaged in the net fishery.

The importance of the introduction of the method of catching codfish with gill-nets was more fully demonstrated than ever before in the winter of 1882–'83, and the operations carried on during that season in the inshore fisheries may be considered as having first fairly established this method of fishing in New England; since, previous to that time, there had been many persons rather skeptical as to the benefits that might be derived from the use of nets for catching cod.

Owing to the almost total failure of the bait supply in the latter part of 1882 and the beginning of 1883, it was found impracticable to carry on the shore cod fishery by the old method of hook-and-line fishing. Such a scarcity of bait had never been previously known, and if the fishermen had been ignorant of the use of gill-nets for the capture of cod, a valuable and important industry must have been almost abandoned, for that season at least, while it may be considered probable that the scarcity of fresh cod, which would have resulted, must have increased the price in our markets very materially, possibly in some cases to such an extent as practically to have placed this desirable article of food beyond the reach of the masses. But during the previous two years the New England fishermen had learned a great deal about catching codfish in nets, not only by practical experience but also from an illustrated pamphlet containing descriptions of all the methods, which had been freely circulated by Professor Baird. The fishermen were, therefore, prepared to meet this unforeseen emergency—an almost entire absence of bait. Instead of being compelled to give up the shore cod fishery, as they otherwise must have done, they met with a success which had seldom or never before been equaled. Such excellent results were obtained by the use of gill-nets that the local papers in the fishing ports contained frequent notices of successful catches. As an instance, may be mentioned the following from the Cape Ann Advertiser of December 8, entitled The good results of net cod fishing: "On Tuesday, December 4, boat Equal, with two men, took 5,000 pounds of large codfish in seven nets off shore, sharing $40 each. The Rising Star has stocked $1,200 the past fortnight fishing in Ipswich Bay. The Morrill Boy has shared $101 to a man net fishing off this shore the past three weeks."

The Morrill Boy met with unexampled success, her crew of five men having shared $320 apiece, clear of all expenses, by the last of December, the time employed being less than six weeks.

From the port of Gloucester alone, according to Captain Martin, there were employed in the gill-net cod fishery during December, 1882, 20 vessels, carrying 124 men. In the period between November 19 and the last of December, 600,000 pounds of large shore codfish were landed in Gloucester, while 150,000 pounds were marketed at Rockport and Ports-

mouth, making a grand total of 750,000 pounds. When to this is added the amount which was probably taken by the vessels from other ports, it is perhaps safe to say that not less than 2,000,000 pounds of this highly valued and most excellent food-fish were caught in nets during the month of December and the latter part of November.

In the early part of the winter of 1882–'83 codfish were taken in nets in great abundance on the rocky shoals in Massachusetts Bay. After the beginning of January, however, the fish were found to be most plentiful in Ipswich Bay; and, in consequence of this, the fleet of shore cod fishermen resorted to that locality, where they met with the most remarkable success, the catch during the first month of 1883 being, it is said, much larger than at any previous time. According to Captain Martin's report for January, 1883, 121,000 pounds of netted cod were landed in Gloucester during the month. Writing to Professor Baird under date of February 6, he made the statement that "ten sail of small vessels which had been fishing in Ipswich Bay, had landed at Rockport, Mass., and Portsmouth, N. H., during the previous twenty days, 230,000 pounds of large codfish." Calculating on this basis, the total catch of the whole fleet during the month of January, 1883, must have been very large.

It was not, however, until the winter of 1883–'84 that the real value and importance of the introduction of gill-nets into our cod fisheries could be fully and fairly estimated. The results obtained during the winter of 1882–'83 had inspired the fishermen with more confidence to engage in the net fishing in the succeeding fall. Consequently, we find that the shore fishermen were prosecuting this method of fishing earlier in the season than ever before, even employing it for the capture of pollock before the winter school of cod had reached the shore grounds. This method of fishing was found especially well adapted for taking the large pollock, which generally visit, in the fall, the inshore fishing grounds in Massachusetts Bay. The singular fact was also discovered that many of the finest pollock, like the cod, may be taken with nets when they utterly refuse to bite a hook, and consequently cannot be captured by the old methods.

Writing under date of October 28, 1883, Captain Martin says: "Pollock and cod have been scarce this fall. Forty sail of small craft, which were out two days on the pollock grounds, came in with 2,000 pounds. Captain Gill, of the boat Gracie, had four cod-nets given him that were worn out in catching codfish last winter. He set them, together with two new ones, and the first night he caught 5,500 pounds of pollock and 400 pounds of large codfish. The pollock averaged 21½ pounds apiece, while those caught on hand-lines averaged 13 pounds apiece. * * * There are three boats which have nets set. They catch three times as much pollock and three times as much codfish as they do on hand-lines. There will be more cod gill-nets used this winter than there have been since they began to use them. * * * There are no spirling this fall,

so that most of the boats will use nets." Under date of October 31, 1883, he gives the following statement, which shows in a most striking manner the advantages that are sometimes derived from the use of gill-nets, and, at the same time, affords us an insight into the way in which the fishermen are often induced to adopt this method of fishing: "The schooner S. W. Craig, of Portland, one of the high-line pollock catchers," says Captain Martin, "was in here last Wednesday. I went aboard to see the skipper and to gain what information I could concerning the pollock fishery. The conversation ran thus: 'How do you find the pollock, captain?' 'Pollock! there ain't none. I have been out two days with 12 men and got 2,000 pounds; that is bad enough.' I said: 'They are catching a good many pollock in nets. Do you see that small boat coming? that is Horace Wiley's; he caught 3,000 pounds the night before last, and caught as many last night. He has got nets.' 'Where does he catch them?' 'Off on a spot of rocks called Brown's.' The captain said: 'I will get some spirling to-night, and go off where they have got their nets set. We will give them fits if we can get some new spirling.' I answered: 'Cap., it is of no use to go where they have got their nets set. If you do you will get no fish.' He replied, 'That be hanged for a yarn! I think you can catch fish with spirling as well as you can with nets.' I said: 'No, sir; you can't do it.'

"The next day he went out with some new spirling to where Wiley was hauling his nets. (The latter had picked out a dory full of cod and pollock, about 2,000 pounds.) He let go his anchor close to the nets and gave the order, 'All hands over lines!' He lay there two hours, but did not catch a fish.

"I was aboard again yesterday, and said: 'Captain, how did they bite where the nets were?' 'That beats all,' he replied; 'we never felt a bite. I am going to Boston to order 25 nets.'"

The boat Gracie, which began fishing with nets about the middle of October, did remarkably well; her crew made $145 apiece up to November 11. According to Captain Martin she had landed 15,000 pounds of large cod and 30,000 pounds of large pollock, and he writes: "Some of the line fishermen have not caught as much as 10,000 pounds in the same time. * * * All the shore-fishing will be done with nets this winter, as the spirling are scarce." This success had the effect to induce others to engage in this fishery, and at the date just given (November 11) there were 16 boats using nets. Each one was provided with 15 nets, each 50 fathoms long, $2\frac{1}{2}$ fathoms deep, with a $9\frac{1}{2}$-inch mesh.

The first vessel to go to Ipswich Bay began fishing there early in November, and on her first trip, with only 5 nets, she caught 6,000 pounds. By November 18 there were 26 boats, setting 390 nets, in Massachusetts Bay. This would make 39,000 yards of netting. Besides this there were two or three vessels in Ipswich Bay; and the schooner Onward, which left Gloucester that day to go around the cape, had a gang of 35 nets. The little schooner Morrill Boy, previously

alluded to, set her nets for the first time on the Sunday preceding November 18, and at the last-mentioned date she had landed 13,000 pounds of cod and pollock, stocking $1,066.75. There were 7 men in the crew, who shared $124 for their week's work, and this, too, when two days of the time were lost on account of high winds. On one day (Wednesday) they made $50 to a man. At the same time bait was so scarce and difficult to obtain that the hook-and line fishermen could do almost nothing. Spirling, when obtainable at all, brought the high price of fifty cents a bucketful, which was a very heavy tax on the cod fishermen. On the six days ending November 25th, 487,000 pounds of cod and pollock were taken in gill-nets set in Massachusetts Bay, and during the same time four small gill-netting vessels caught 55,000 pounds of fish in Ipswich Bay. Writing under the last-mentioned date Captain Martin says that "about all the fish caught inshore are taken by nets;" and he remarks that "if they could be knit fast enough the whole fleet would have nets." So urgent was the demand for cod-nets at that time that many of the women at Gloucester were employed in making them. Captain Martin tells us that "everybody is at work," and he continues, "A great winter's work is anticipated." By the latter part of November the fleet of netters had increased to 35 vessels, and it is probable that a larger number might have been engaged in this fishery at that date if they could have obtained gear. The fishermen were often bothered to get nets, and on one occasion several boats had to wait four days to get a supply of glass floats, which are so essential in this fishery. By the last of January the fleet numbered 52 vessels, which appears to be the maximum, for about the middle of March only 42 schooners were engaged in netting, a few of the boats having probably worn out their nets, and not caring to refit so late in the season, left shore-fishing to go to the outer banks, or else, perhaps, to fit out for the spring mackerel fishery. In addition to the vessels, a few open boats engaged in the gill-net cod fishery last winter; and as early as December, according to Captain Martin, five dories were thus employed from Salisbury, each having three nets.

The gill-net fishery has not been exempt from loss of gear, though perhaps this loss is much less than it would be if trawls only were used. In a gale that occurred on January 4, 1884, considerable property was destroyed or injured. Captain Martin reports that thirty-five nets were lost and many others badly damaged. "No fish," he says, "were caught for four days after the storm." Curiously enough, the fishermen say that they never get many fish just previous to a heavy storm, and the netters have learned by experience that a sudden falling off in the catch is generally an indication of the near approach of bad weather. Another feature of the net fishing is that, in addition to the various species of the *Gadidæ* which have been taken, porpoises (locally called "puffers"), monk-fish or fishing-frogs, and dogfish (*Squalus*) have been caught, though fortunately the latter, which are considered especially

obnoxious by net fishermen, are not on the coast during the coldest weather.

In addition to the instances already given of catches made last winter, the following have been recorded. For the week ending December 9, 1883, there were landed at Gloucester 590,000 pounds of netted fish, while 84,000 pounds were marketed at the two ports of Rockport and Portsmouth, the week's catch amounting to the total of 674,000 pounds. The following week Gloucester received 430,000 pounds, Rockport and Portsmouth a total of 81,000, and Swampscott 48,000, making a total of 559,000 pounds. This large amount was taken, too, when the weather was so unfavorable that nothing could be done for three nights and days of the week. For the week ending March 23, 1884, there were landed 520,000 pounds of cod that had been caught in gill-nets. For the week ending March 30, 18 vessels landed 483,000 pounds. The following statement of the total amount of fish captured by the use of gill-nets during the past winter has been compiled for me by Mr. Chas. W. Smiley from the reports of Captain Martin, who has made it a special object to collect all possible statistics and information relative to this important branch of the fisheries.

Total amount of fish landed from gill-nets during the months of October, November, and December, 1883, *and January, February, March, and April,* 1884, *compiled from the note-books of Capt. S. J. Martin, Gloucester, Mass.*

Months.	Cod.	Pollock.	Haddock.	Hake.	Cusk.	Grand total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
October, 1883	35, 500	573, 000	45, 000	36, 000	30, 000	709, 500
November, 1883	1, 275, 500	185, 000	249, 000	20, 300	9, 000	1, 738, 800
December, 1883	1, 373, 000	3, 000	264, 000		15, 000	1, 655, 000
January, 1884	932, 000		40, 000			972, 000
February, 1884	923, 000		75, 000			998, 000
March, 1884	1, 248, 000					1, 248, 000
April, 1884	705, 000					705, 000
Total	6, 492, 000	761, 000	673, 000	56, 300	54, 000	8, 036, 300

An important matter for consideration in connection with the cod gill-net fishery is that not only can fishing be successfully carried on, even when bait is not obtainable (for, of course, no bait is required when nets are used), but there is a very great saving of money and time that must be expended in procuring the bait and baiting the lines when hook-and-line fishing is followed. As an instance of the expense involved, it may be stated that the average bait-bill of a shore-trawler is not, under ordinary circumstances, less than from $150 to $250 per month, when herring are as high as they usually are in winter. It is, therefore, safe to estimate that when as many vessels are employed in gill-netting as there have been during the past two winters, the money saved to the fishermen, which otherwise must have been paid for bait, could not be less than from $30,000 to $70,000 each season. Besides this, a very large percentage of the time is saved, as has been stated, which otherwise must be lost in seeking for bait.

In this connection it may be well to say that last winter nets cost

$14.25 apiece, and the glass floats could not be obtained cheaper than 22 cents each. It will, therefore, be seen that a "set of gear" for a vessel carrying thirty to thirty-five nets costs a considerable sum, and if this had to be renewed every few weeks, it would be a material drawback to the prosperity of the fishery.

In pursuing the cod gill-net fishery the men have been to some extent handicapped by the rotting of their nets, and in some cases—more especially in the fall, when the waters are filled with animal life—the nets have decayed very rapidly, so that they have been found quite unfitted for use after being in the water for five or six weeks. While at Gloucester last fall I had this matter brought to my attention by the fishermen, who were anxious to obtain some preservative which would prevent their nets from rotting. I addressed a letter to Professor Baird on the subject, and the result was that the matter having been brought to the notice of Messrs. Horner & Hyde, of Baltimore, these gentlemen forwarded to Gloucester a barrel of their net preservative for the purpose of having its merits tested on the cod gill-nets. It was applied to a portion of the nets of several small vessels in January last, and after the apparatus had been in use from that time to the middle of April sections of the net so prepared were forwarded to me, at Washington, together with a statement by Captain Martin as to what the fishermen said regarding its use. Previous to this, however, I had talked with some of the fishermen concerning the nets treated with Horner & Hyde's preservative, and they asserted very positively that not only did it prevent the nets from rotting, but that they were fully impressed with the idea that a great many more fish were caught in nets so treated than in the others prepared in the ordinary way. The sample of netting sent me by Captain Martin shows little sign of deterioration, notwithstanding the fact that the net from which it was taken had been in constant use for upwards of three months.

Whether future trials of this material will sustain the statements made by the fishermen who have already experimented with it, I am unable to say, but if such should be the case there can be no question but that a very important step has been attained through the labors of the Commission in perfecting the work of cod gill-netting, which it commenced in American waters five years ago.

It is perhaps proper to state here that some of the North Carolina fishermen who have tried Horner & Hyde's treatment on their nets have complained most bitterly that their gear was much injured, if not almost entirely ruined, by it. I have seen copies of two letters from fishermen of the South containing such complaints. This being the case, it will perhaps require a longer test to settle definitely whether or not this treatment has all the merit that the Gloucester fishermen say it has, though it is altogether possible, the conditions being so very different, that what might give excellent satisfaction when properly applied and intelligently used in the ocean fisheries, might prove unsatisfactory under other conditions.

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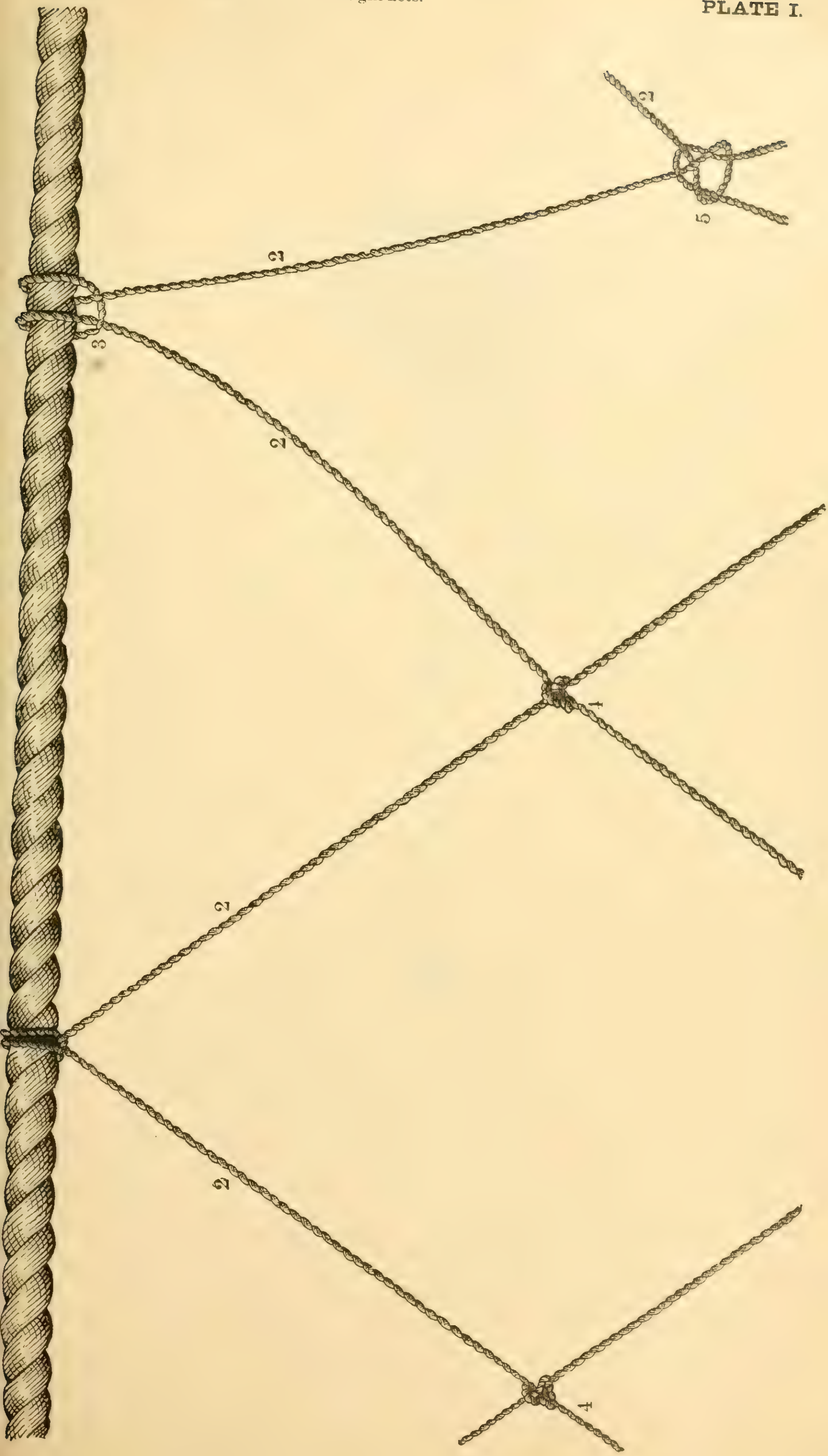

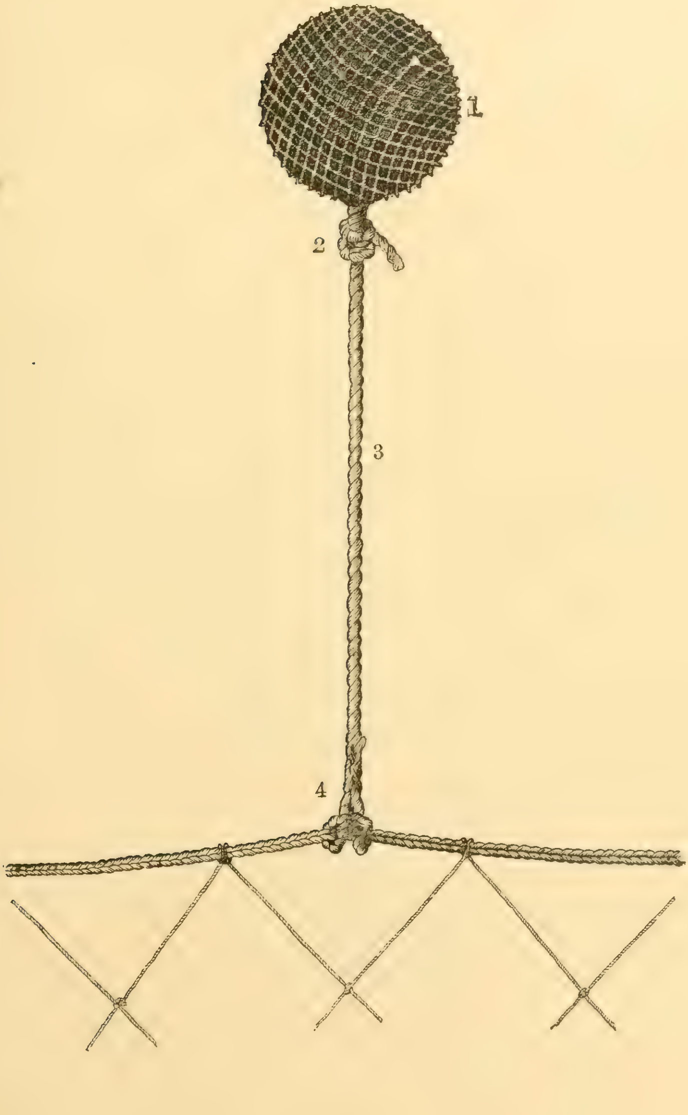
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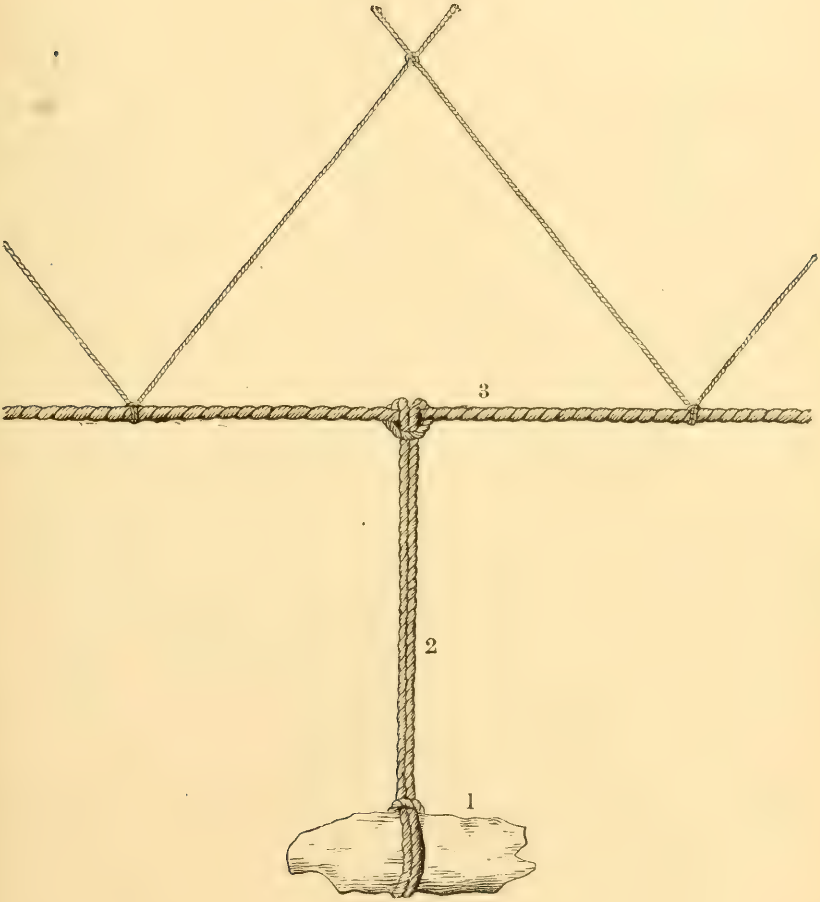
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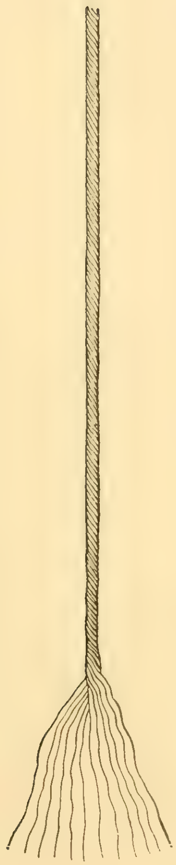

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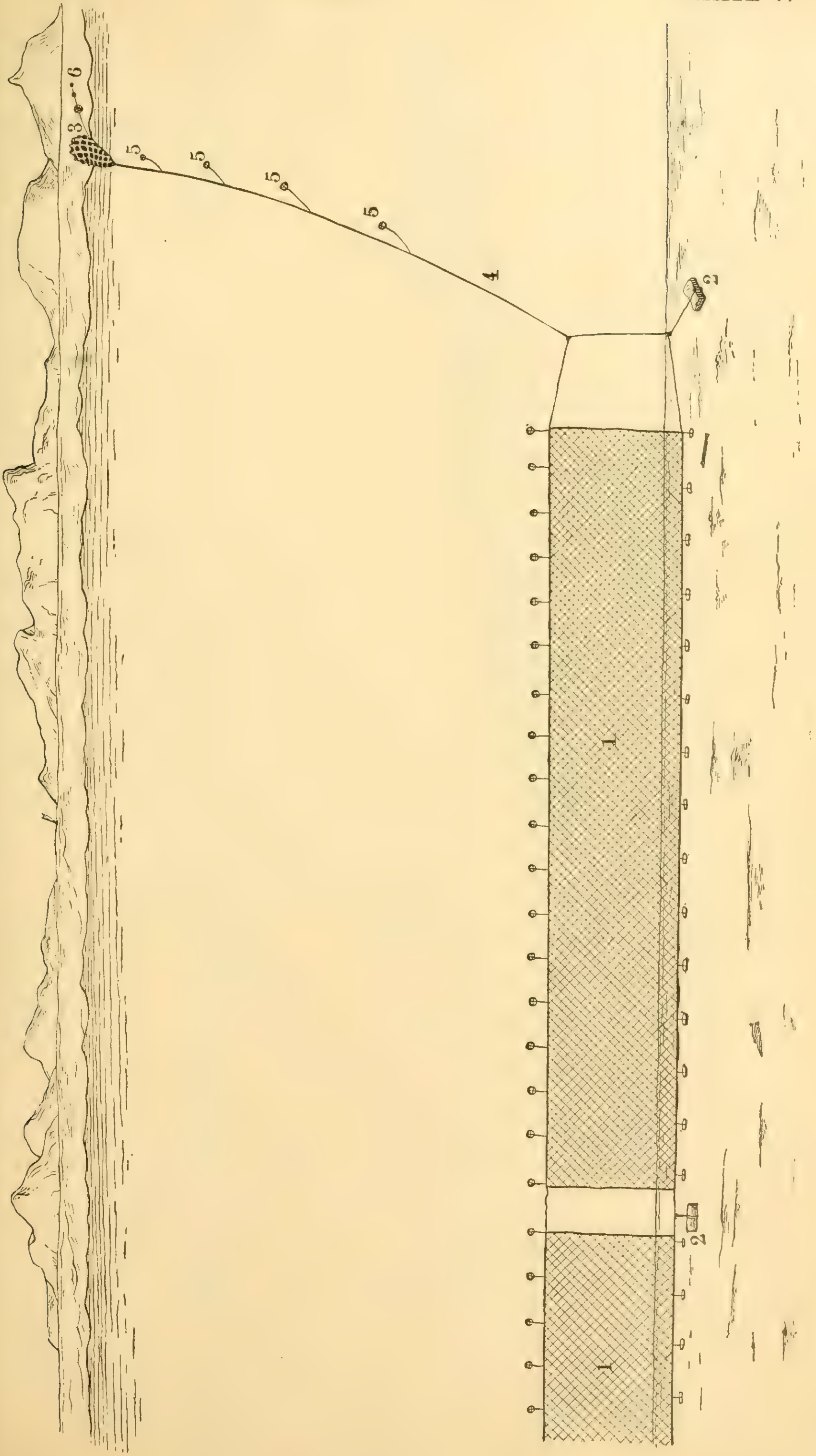

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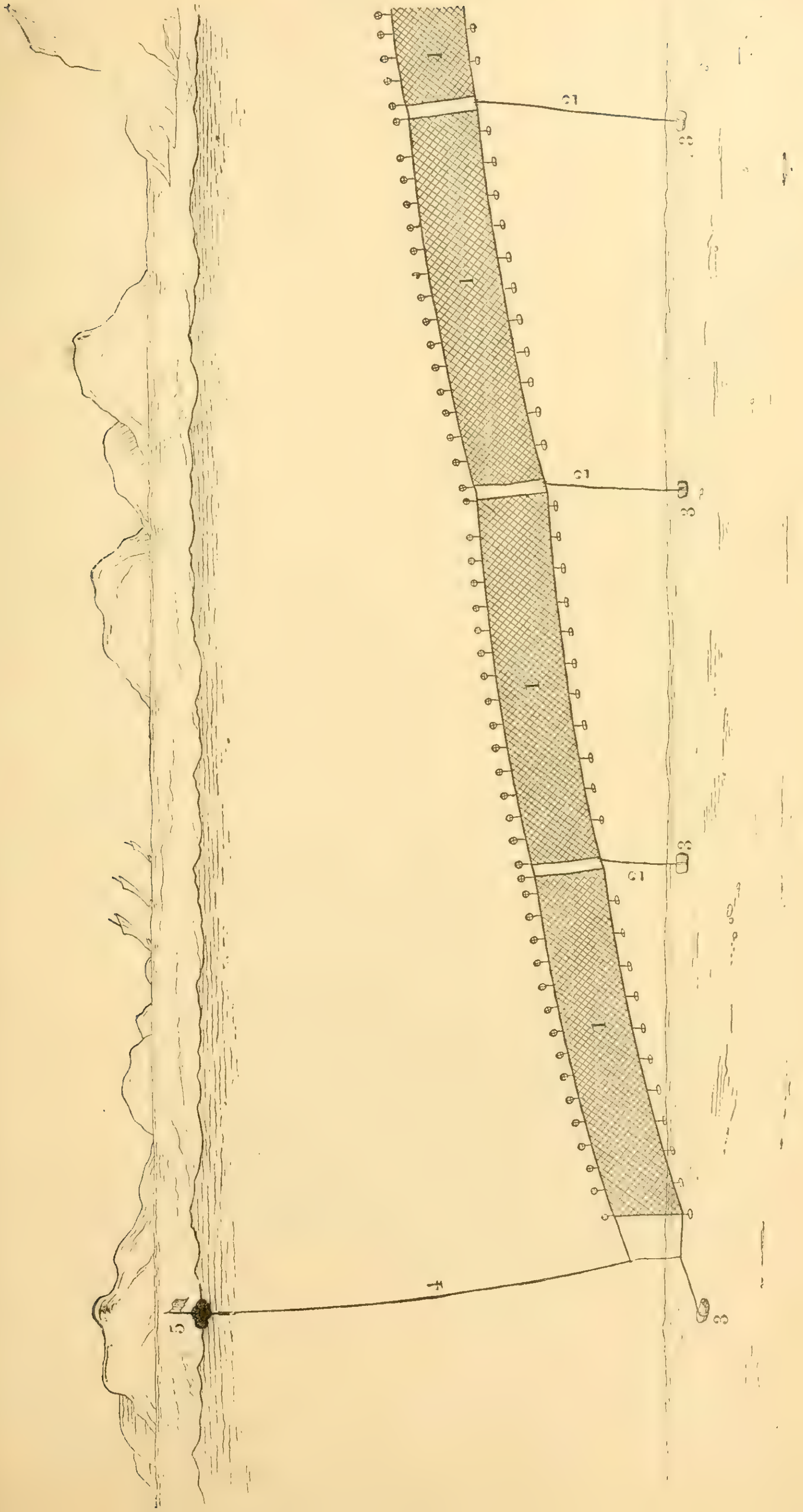

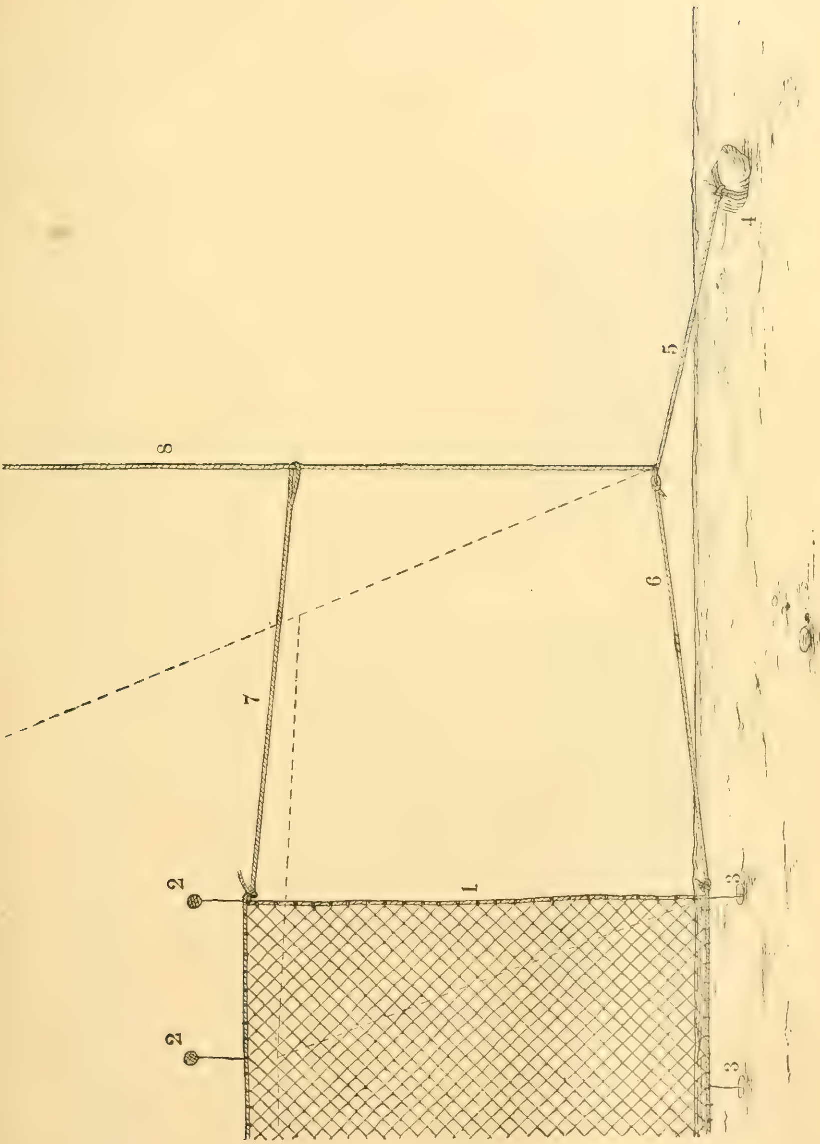
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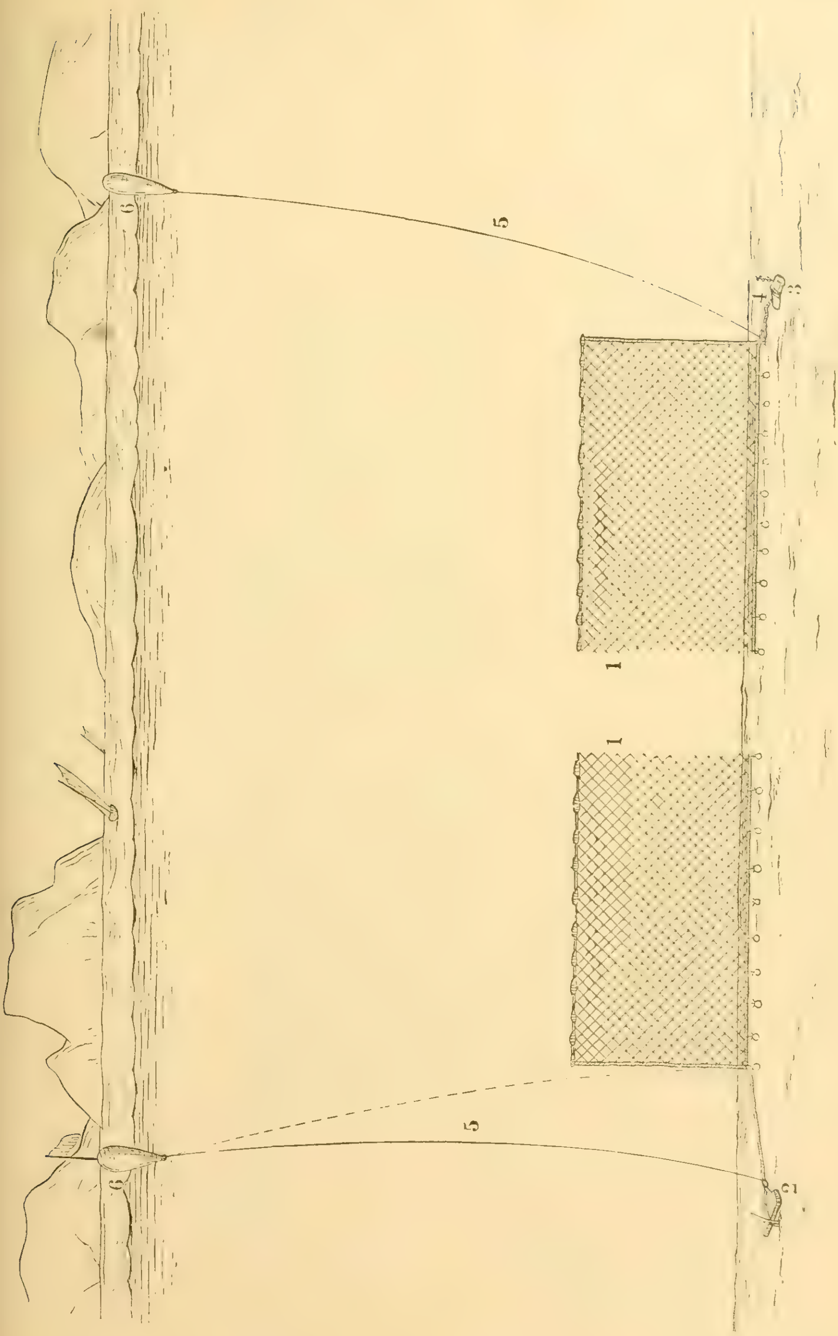

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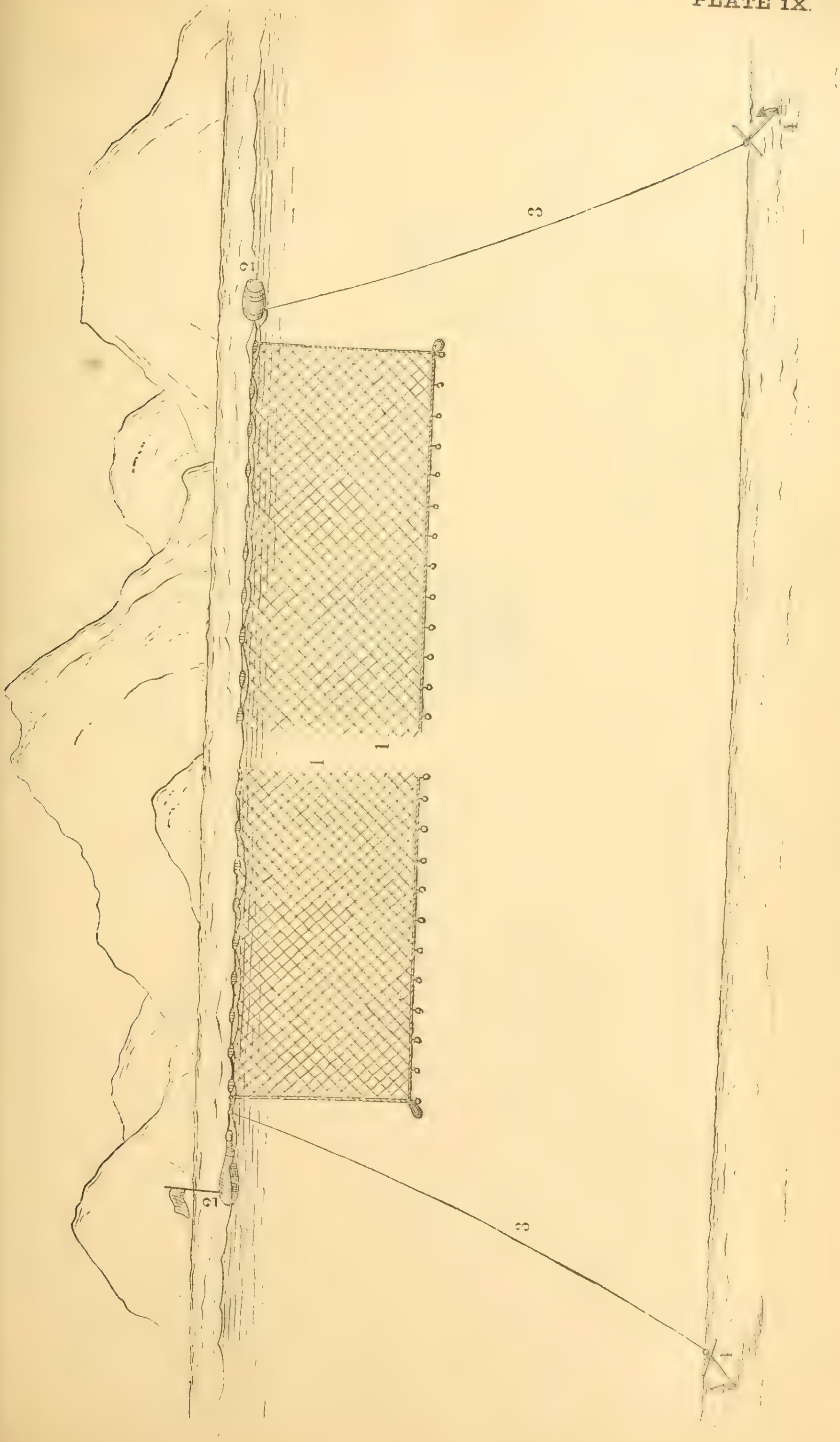

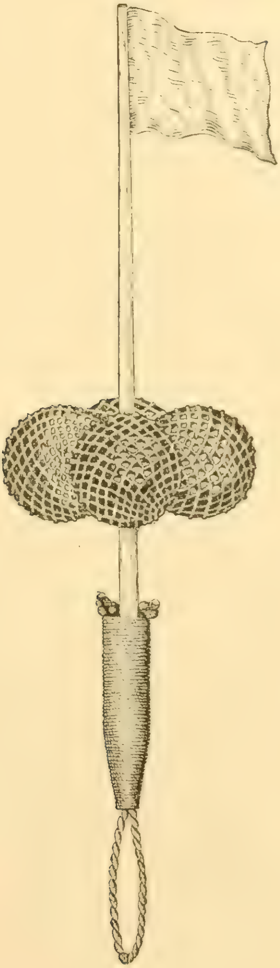

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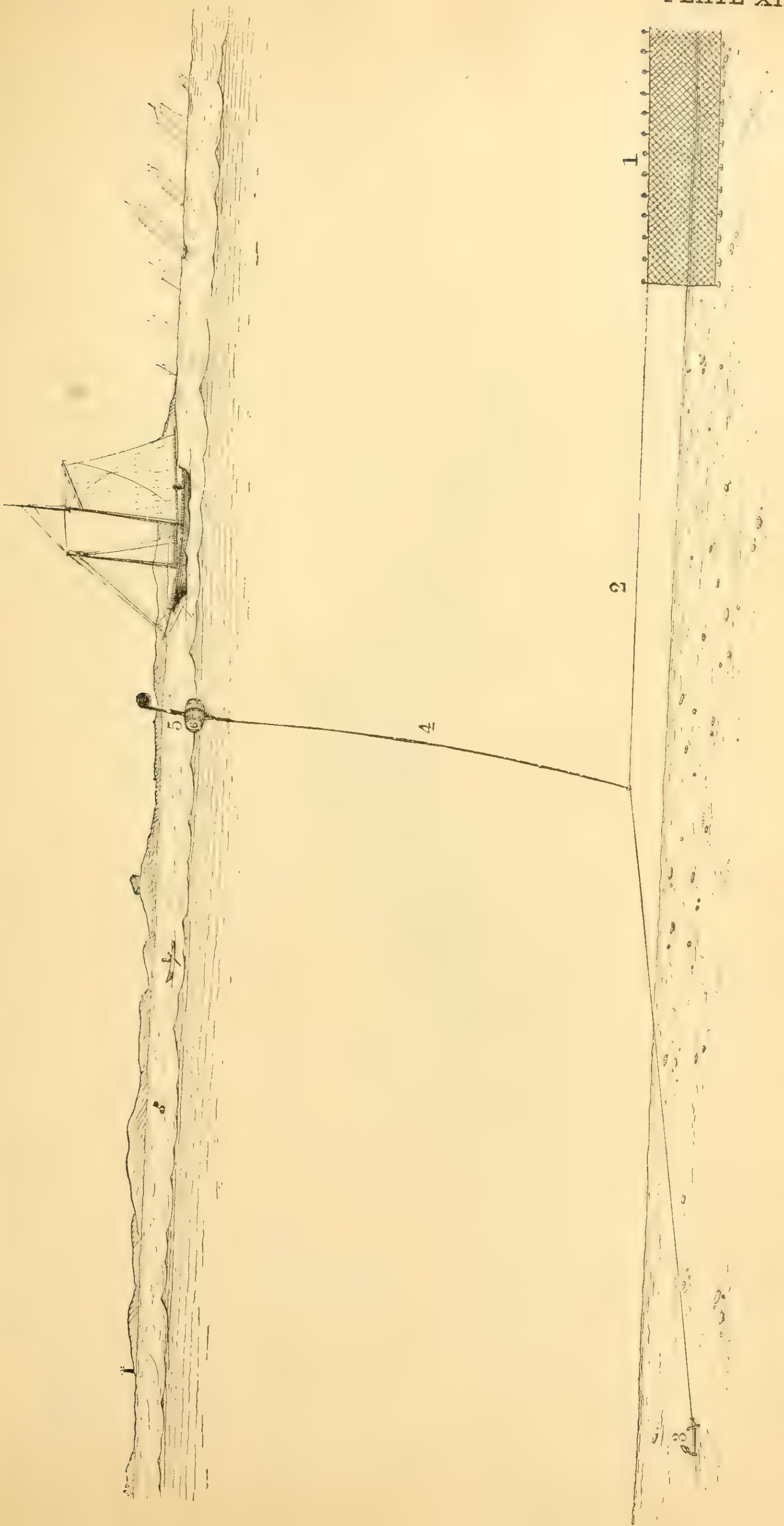

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XX.—THE ICELANDIC HALIBUT FISHERY—AN ACCOUNT OF THE VOYAGES OF THREE GLOUCESTER SCHOONERS TO THE FISHING GROUNDS NEAR THE NORTH COAST OF ICELAND.

By Capt. J. W. Collins.

In the spring of this year (1884) several of the Gloucester fishing schooners ventured on a new enterprise, by making trips to the grounds near the coast of Iceland for the purpose of obtaining fares of flitched halibut and halibut fins. These were to be brought home in a salted condition, the former to be cured as "smoked halibut," and the latter packed in barrels, with brine, and sold as pickled fish. Three vessels went to Iceland—the Alice M. Williams, Capt. George W. Pendleton; the Concord, Capt. John Dago; and the David A. Story, Capt. Joseph Ryan. All have recently arrived home, and the last to discharge has finished taking out her cargo. The results that have been obtained will be submitted, as well as a brief account of the trips, based upon information that has been furnished by the captains of the respective vessels, and upon notes kept by them while on their voyages.

Before entering on a description of these cruises it may, perhaps, be well to note that the fishing grounds about Iceland have heretofore been practically unknown to American fishermen. The only American fishing vessel that has previously visited Iceland was the schooner Membrino Chief, Capt. John S. McQuin. He went there in 1873 on a salt halibut trip, but set his trawl lines only once. Therefore, little or nothing was learned of the abundance of halibut, while his failure to secure a fare has heretofore influenced others so much as to prevent them from making a trip to the same region.

Though the vessels that went there this year have met with very flattering success, it is by no means improbable that greater familiarity with the region may result in the discovery by our fishermen of large areas of sea bottom where halibut occur in great abundance, and which, on an experimental cruise like this first one, they would be unlikely to find.

Halibut also occur in great abundance, according to Mr. F. M. Wallem, on certain parts of the Norwegian coast. And this gentleman, while at the International Fisheries Exhibition at London, in the summer of 1883, told me that he would give any desired information relative to

the localities where halibut are plenty on the Norwegian coast, should American vessels care to visit that region. I have called the attention of our fishermen to the kind and courteous offer made by Mr. Wallem, and it is probable that some of the more enterprising skippers may, in the future, venture even so far as Norway in pursuit of halibut.

The schooner Alice M. Williams, which was the first to start for Iceland and was also the first to arrive home, sailed from Gloucester May 1, and reached that port on her return September 13, her voyage occupying four months and 12 days. The outward passage was made without any noteworthy incident. The vessel ran across the southern part of the Grand Bank, and on the southeast part of the bank fell in with numerous icebergs, the only ice that was seen on the passage. On May 21, land was sighted at Skaga, where a boat was sent on shore on the following day.* On the 25th the Williams ran into Ise Fiord.

When the schooner arrived at Ise Fiord, Captain Pendleton was informed by the local magistrate, and also by a Norwegian named J. Eglehus, a naturalized citizen of the island, that American vessels could not be permitted to fill water, land empty barrels, salt, &c., unless a special arrangement was made, whereby Eglehus chartered the Alice M. Williams, thereby insuring to her the right to land such material as that mentioned above, to fill water, to have free access to the harbors of Iceland, and to fish within 3 miles of the land. It was not, however, permissible to land any fish of any kind whatever, even if they were to be taken on board of the vessel again. For the privileges above enumerated 400 crowns were charged, and, besides this, a duty had to be paid on all salt that was landed; though in every instance the salt was again taken on board of the schooner and used on fish.

The captains of all the schooners that went to Iceland were told that halibut were most numerous inside of the 3-mile limit, and this information was doubtless given in good faith, as it is probable that the Icelanders seldom go more than 3 miles distant from the land in their open boats. The natives could therefore have little knowledge of the abundance of fish farther out, except as they learned of it from the British or French fishermen, who catch halibut only in small numbers on hand-lines. As a matter of fact, however, the American schooners caught nearly all of their fish from 5 to 25 miles distant from the land, none or almost none inside of 3 miles, while the majority of the halibut were taken outside of 12 to 15 miles from the coast. The privilege which was granted to fish inside the limit was, therefore, practically of no value to our vessels.

It may be stated as explanatory of the above, that vessels going for fares of flitched halibut are compelled to carry a large amount of salt to cure their fish—often amounting to nearly enough to fill the hold—and a considerable number of barrels, to hold the halibut fins, fresh water,

* Captain Pendleton had as one of his crew a man who spoke Danish and acted in the capacity of an interpreter.

&c., besides more or less spare gear, to supply any loss that may occur. As a result, a vessel is very much lumbered up, especially if fish are found abundant, and good catches of halibut for two or three days in succession generally fill all available space, making a "block"; and unless barrels, salt, and spare gear can be landed temporarily, much valuable time must be lost while the crews are waiting for the newly-caught fish to "settle."

If arrangements could be made by the United States with the government of Denmark, whereby salt, barrels, gear, and even halibut fins (in barrels), could be landed by our fishermen, temporarily, under bond, great benefit would accrue to the salt halibut fishery, and New England vessels would be able to pursue their voyages under far more favorable conditions than they otherwise might be permitted to enjoy.

In this connection, it is proper to remark that the captains of the three schooners that have been to Iceland agree in saying that they were treated by the officials on the island with the utmost courtesy and consideration. So far as possible, consistent with a conscientious dischaige of their duty, these gentlemen did all that might be expected to relieve our fishermen from any unnecessary annoyance or embarrassment that otherwise might have attended a fishing voyage to a strange country.

The day after the arrival of the Alice M. Williams at Ise Fiord, May 26, her crew was occupied in landing barrels (which were afterward taken on board and filled with halibut fins), filling water, &c., and on the 27th she got under way and stood off to the fishing ground, which was not far from the harbor.

On the 18th, the trawls were set, and 48 halibut were taken. This did not prove satisfactory, and the vessel worked along shore, and the following day, acting in accordance with information gained from the natives, the lines were shot in "Hague" Fiord. Poor results were obtained, and on the 30th the Williams stood off until she reached a depth of 50 fathoms. Thick weather came on, and, working inshore, the schooner anchored under the land on the 1st of June. The following day she got under way, with a southerly wind, and ran to the northward about 50 miles, where the trawls were set and a catch of 28 halibut was made. The weather was more or less foggy most of the time until the 24th, but moderate enough to set and haul the gear. From the latter date until June 28 the weather was rough, with frequent heavy squalls, so that the schooner ran in and remained in harbor.* On the last-mentioned date she got under way and ran off on the bank, and fishing operations were carried on during the last two days of the month. During June, the trawl-lines were shot 27 times; in July, 20 times; and only a few sets were made in August. At first two sets were made each day, if the weather permitted, but later it was found to be more profitable to make but one set in twenty-four hours, and to shift the position every

*By consulting the log kept by Captain Ryan, it will be seen that the weather was fairly moderate June 25, and fishing was carried on June 28.

time the gear was hauled. In the appended table the dates when fishing was carried on, during June, July, and August, are given, and the number of halibut taken each day which were large enough to be flitched and salted down.

The heaviest catch was made on June 5, when 420 halibut were taken, and Captain Pendleton estimates that they weighed upwards of 50,000 pounds in a fresh condition. On several occasions he thinks as many as 30,000 pounds or more of halibut were taken in a single day; this estimate being, of course, given for the fish as they came from the water.

Speaking in general terms, the Williams fished between the parallels of 66° 10′ and 66° 37′ north latitude, and 21° 40′ to 23° 10′ west longitude, trials being made in depths varying from 25 to 125 fathoms. The character of the bottom where the halibut were mostly taken was rather rough and broken, with an abundance of quahogs (probably *Cyprina Islandica*), whelks (*Buccinum*), and crabs, while sponges, moss, and other invertebrates were hauled up on the lines.

From the 7th to the 14th of July the Williams fished in the vicinity of North Cape, in 35 to 40 fathoms of water, 7 to 14 miles from the land, the cape bearing from W. ½ N. to W.SW.

During the latter part of June, and as late as July 5, large masses of floe-ice were seen stretching along from northeast to southwest as far as the eye could extend, while no water could be seen to the northwest. For several days fishing was carried on near the edge of the ice, and at one time the floe came within one-half mile of the schooner, but did not, however, interfere with fishing.

Captain Pendleton states that the weather, as a rule, was foggy, but reasonably moderate for so high a latitude—not so good on an average as the weather is on the Grand Bank in summer. From the 12th to the 18th of July the weather was stormy and rough, and most of this time the vessel lay in harbor. These spells of rough weather were not wholly lost time, for the days spent in harbor gave the fish an opportunity to settle, and the crew took advantage of the chance thus offered to "pack up" their flitches, and secure room for salting more halibut when the weather proved suitable for fishing operations. July 30 and 31 the Williams was in Ise Fiord, where she lay until August 6, when she started again for the fishing ground off Cape North. The last day's fishing was on August 14, from which time until the 20th the vessel lay in harbor, the crew engaged getting material on board, which had been landed, and in making all necessary preparation for the home passage.

The Alice M. Williams sailed from Ise Fiord for home August 20, reached Belle Isle, Labrador, September 4, Cape Sable a week later, and at midnight of the 12th Thatcher's Island lights were seen, the vessel reaching Gloucester Harbor early on the morning of September 13. The passage home was uneventful, and only one incident connected with it seems worthy of special mention; this, however, being of unusual in-

terest in view of the discussion that has been going on in this country relative to the comparative merits, so far as seaworthiness is concerned, of the English smacks and the American fishing schooners. Considerable numbers of welled ketch-rigged smacks—locally termed "codmen"—visit Iceland each summer in pursuit of cod. These vessels, for the most part, belong at Grimsby, England. Captain Pendleton tells me that on the day he left Iceland for home the wind came on to blow heavy when he was some 30 to 40 miles off shore, and a bad sea got up. His vessel was pretty deep in the water, and the seas tumbled aboard her so much that it became extremely uncomfortable, not to say dangerous, to attempt to carry sail longer and continue on his course. He therefore hove to under a double-reefed foresail. Soon after he hove to he was passed by an English smack that was carrying a single-reefed mainsail and a whole (stay) foresail. Captain Pendleton speaks in the highest terms and in the most emphatic manner of the behavior of this vessel, which he says was going along so dry and comfortable that many of her crew did not even have on oil clothes, and he judged she was making a speed of 11 knots, at the least. Considering that the Alice M. Williams is one of the finest of the clipper fleet sailing from Gloucester, comment is unnecessary.

Captain Pendleton states that the currents on the Icelandic fishing grounds are very irregular and uncertain, both as to direction and strength. It is impossible to tell how the tides are going to run, or how strong they will be. Generally speaking, the current does not run swifter than from one-half to one mile an hour—occasionally two knots—and the general trend is back and forth along the coast, excepting off Cape North, where the tide sweeps around the compass.

The halibut taken at Iceland are very much larger than those caught at Greenland, and, what is peculiar, the former are chiefly white fish, while the latter are nearly all gray. In the early part of his trip Captain Pendleton caught considerable quantities of codfish, part of which he used for halibut bait, but he estimates that he threw overboard codfish to the value of $400 or $500. He was obliged to do this because he had no room to keep them on board, and as he could not land any fish, they had to be thrown away. The traders at Iceland would have been glad to buy the fish if they had been permitted to do so, as they could have got them at very reasonable rates; but trade of this kind was strictly forbidden.*

The Alice M. Williams is 77.96 tons register. She carried a crew of 16 men all told,† and 7 dories; set about 800 hooks to a dory. She weighed off (including 2,000 pounds of thin or "loggy" fish) 162,000 pounds of flitches, besides which she had 65 barrels of fins; her gross stock was $8,317.30, and the crew shared $268.90 each. The prices

* Herring were seen in extraordinary abundance about the 1st of August, in the vicinity of North Cape.

† An Icelander was hired for about 40 days in July and August.

obtained this year are very much lower than they were last year. For the large flitches 5 cents per pound was paid, the small flitches brought only half price, while 1 cent per pound was paid for loggy fish. Halibut fins, which are considered quite a delicacy, are worth $9 per barrel.

Table showing the daily catch of the schooner Alice M. Williams during June, July, and August.

Date.	Number of halibut salted.	Date.	Number of halibut salted.	Date.	Number of halibut salted.
June 1	25	June 18	307	July 21	50
2	28	19	104	22	100
3	87	20	113	23	160
4	150	21	244	24	100
5	420	22	173	25	240
6	290	23	150	26	274
7	151	July 1	125	27	11
8	196	2	166	28	87
9	120	3	160	29	140
10	136	4	245	Aug. 9	129
11	None.	5	90	10	113
12	None.	6	172	11	90
13	36	7	126	12	124
14	256	8	283	13	189
15	109	9	117	14	14
16	178	10	53		
17	102	11	57	Total	6,890

Total catch for the trip about 8,000 fish. This would probably include the small halibut, some of which were used for bait, and others that were too small to be taken into the daily account.

The Concord left home May 12, but on her passage down the Nova Scotia coast she sprung a leak, and put into Arichat, Cape Breton, for repairs. May 27 she left Arichat, and June 10 made Iceland; the following day she went into Reykjavik, where a pilot was obtained. After making the necessary preparations for fishing, namely, landing barrels, filling water, &c., for which privileges 400 crowns were paid, the Concord proceeded to the fishing ground and commenced operations.

Captain Dago says that at first he generally set the trawls twice a day, but he soon found that a single set, and a change in the position each day, resulted far more satisfactorily, a larger quantity of fish being taken with far less fatigue to the men. He estimates that he took about 25,000 pounds of fresh halibut as his largest day's catch. The trawls were set 62 times, fishing being carried on in depths varying from 30 to 80 fathoms, 5 to 25 miles from the land, but generally outside of 15 miles. For about a week the Concord fished alongside of the ice floe, which was distant from the vessel from 2 to 4 miles. Trials were made along the coast for a distance of about 180 miles, but most of the halibut were caught in the vicinity of Cape North. The fishing ground is so extensive, however, that Captain Dago says he seldom saw the other two American schooners. This was due, in a measure, to the prevalence of thick weather for a considerable portion of the time. He reports seeing a fleet of about 40 French topsail schooners, of the old-style type, ranging from 80 to 130 tons, a few ketch-rigged French vessels, 50 to 70 tons, and a small fleet, say 15 to 20, of English ketch-

rigged smacks, fishing for cod at Iceland. The captains and crews of these vessels, although they had been familiar with the Iceland fisheries for many years, were very much astonished at the large catches of halibut that were made by the Americans. They predicted our men would get no fish because they believed the hooks used by our fishermen are too small. The Americans were also told, very emphatically, that they could not possibly use trawl-lines on the Icelandic fishing grounds, because the tide would be sure to sink their buoys. But men who had fished on all the grounds from George's Bank to Greenland, and in the "deep water," in winter, were not to be easily discouraged, and the result proved that, though they had never previously been to Iceland, they had a better conception of what it was possible to do than the foreign fishermen had, notwithstanding the latter were familiar with the locality.*

After having had good fishing for several days, it became necessary for the Concord to land salt, spare gear, &c. A duty of 10 crowns was paid on the salt, though in this as in other cases the salt was again taken on board and used on fish.

Captain Dago states that the Icelanders wished very much to purchase the halibut heads, which, strangely enough, are thrown away by American fishermen as of no value, while they are prized more highly in Iceland than any other portion of the fish; indeed, being the only part that is considered specially desirable for food. Had it been permissible to sell the fish, the Icelanders might have procured large numbers of heads for almost nothing.

Captain Dago describes the bottom on the fishing bank as "catchy," and mentions having taken, besides the varieties of invertebrates already mentioned, two or three other kinds, among which were sea lemons. He also mentions, as also do the other captains, that large numbers of small and medium-sized halibut were caught, upon which were marked the initials of French fishermen, who, seldom making any use of these fish, are accustomed to thus mutilate many which they catch. If they had the good sense to mark on a fish the date of its capture and its approximate weight, much interesting data could be obtained relative to the yearly growth of the halibut.

The French salt their catch of cod, which are taken on hand-lines. The English also fish with hand-lines ("at a drift") for cod, which they salt until a fare—enough fish to fill the available space—is obtained, after which the catch is put in the well to be taken alive to England, the salted part of the cargo generally being landed at the Faroe or the Shetland Islands. Halibut are also saved alive in the well, but instead of allowing them to settle down on the bottom of the vessel, the Eng-

*It is, perhaps, not to be wondered at that the European fishermen should think that extraordinarily large hooks are required to catch halibut, for they use for the capture of cod extravagantly big hooks—more than double the size of the hooks employed by Americans.

lish fishermen suspend the halibut by their tails, believing that the fish will keep alive much longer in this condition than in any other manner.

The Concord was the last to leave Iceland, starting on her homeward passage August 31. She had a fine run as far as the Grand Bank, which she reached in nine days, having passed within sight of Cape Farewell on the way. From the Grand Bank home she encountered strong westerly winds and a rough sea, but arrived at Gloucester on the morning of September 18, having made the passage in a little over seventeen days.

The Concord is 93.63 tons register, carried the same number of men and boats that the Alice M. Williams had, and set from 450 to 600 hooks to a dory. No account was kept of the number of halibut taken, but Captain Dago estimates that he had about 6,000. The total weight of flitches was 152,425 pounds, divided as follows: 142,150 pounds of large, 8,975 pounds of small, and 1,300 pounds of "loggy" fish. Besides, there were 60 barrels of fins. Gross stock, $7,884.87.

The David A. Story sailed for Iceland May 12, ran a straight course, after passing Cape Spear, Newfoundland (saw no ice); June 6 made the land on the southern coast of Iceland, and three days later reached Ise Fiord, where the vessel lay in harbor until June 12, the weather, in the mean time, being stormy. Nothing was landed, however, and no pilot was taken, but a general idea was obtained of the localities where halibut might be found. Captain Ryan fished chiefly in the vicinity of North Cape, practically on the same ground where the other schooners got their fares. No halibut were taken inside of the 3-mile limit, fishing being carried on from 5 to 20 miles from the land, in depths varying from 35 to 55 fathoms; the bottom rough, clean, and very "catchy." This kind of bottom, which is most generally frequented by halibut, is very hard on fishing gear, since the lines catch on the rocks and are parted and sometimes lost. After fishing a week and taking about 1,500 halibut, he ran into Ise Fiord, where an arrangement was made, as with the Alice M. Williams, for a permit to land spare material, fill water, &c., for which 400 crowns were paid. The spare gear, empty barrels, and 20 hogsheads of salt were put on shore, a duty of 16 crowns* being paid on the salt, which at a later date was taken on board of the vessel and used on fish.

Captain Ryan also reports having seen the floe ice for 48 hours, bearing about northwest from his vessel, and distant about 1½ miles. He saw several steamers in the floe engaged in catching seals. These were probably a portion of the Dundee (Scotland) or the Newfoundland fleets. He also mentions the French topsail schooners, which he says are full, old-fashioned crafts, ranging from 80 to 125 tons; while the English smacks were from 60 to 100 tons.

The following extracts from Captain Ryan's log-book will give a good

* A Danish crown equals about 27½ cents.

idea of the daily fishing, the weather, &c., during his stay at Iceland, and on his passage home. He kept no notes of his outward passage.

Date.		Entries.	No. of hauls of trawls made daily.	No. of halibut salted each day.
June	9	Arrival at Ise Fiord, Iceland	......	......
	10	[No note]	......	......
	11	Stormy. Laying in harbor	......	......
	12	Fine [weather]. Got under way	......	......
	13	Fine and clear. Came to anchor and made first set	1	....
	14	Moderate wind [in the morning]. Made two berths. 11 p. m., stormy	2	191
	15	Clear and windy *	2	244
	16	Windy [probably a fresh breeze]	2	210
	17	Very fine; wind changeable	2	162
	18	Blustery, with rain	2	283
	19	Strong westerly wind	2	178
	20	Fine in a. m.; stormy at 6 p. m. Got under way	2	221
	21	Went into Ise Fiord. Got water	......	......
	22	Got under way [and left the harbor]. At 8 p. m. anchored and set trawls	......	......
	23	Windy from the east. Remained at anchor	1	107
	24	Easterly gale, with snow. At anchor	2	†240
	25	A. m. fine; p. m. stormy. Shifted a berth	1	184
	26	At 5 a. m., strong westerly gale. At anchor	......	......
	27	Strong westerly gale with rain. At anchor	......	......
	28	Strong westerly wind. Moderated in p. m. Got trawls and got under way	1	132
	29	Moderate in p. m. Set [trawls]	1	......
	30	Got under way in the morning [after landing gear] and set under sail. Blustery at midnight	2	53
July	1	A. m. very fine; p. m. windy. Got under way at North Cape	2	202
	2	A. m. very moderate. Anchored and set trawls; up anchor [in p. m.], shifted berth, and set again	1	119
	3	[Weather] fine, moderate, and clear. Shifted a berth	2	243
	4	Very fine and moderate. Shifted berths	2	283
	5	Very fine, moderate, and clear. Up anchor and shifted berths	2	208
	6	Very moderate, with easterly wind and fog	2	263
	7	Moderate, with fog	[2]	220
	8	Windy from eastward. Got under way and ran into Ise Fiord	......	......
	9	Laying at anchor in Ise Fiord	......	......
	10	In Ise Fiord [during a. m.]. Got under way and went to sea	......	......
	11	Strong easterly wind. Did not fish	......	......
	12	Strong easterly wind. Went into Doyer (?) Fiord and anchored	......	......
	13	Strong wind. Laying at anchor. Filled water	......	......
	14	Got under way, with strong easterly wind. Anchored	......	......
	15	Laying at anchor in Adevig (?). Strong wind	......	......
	16	Laying in Adevig	......	......
	17	At 6 a. m. got under way. Worked northerly, and set trawls. Fine weather	1	......
	18	Very moderate and clear. Weighed anchor and set under sail	?	?
	19	Fine [weather]. Left North Cape and stood to the westward. Set under sail	2	54
	20	Foggy in a. m.; clear in p. m. Set under sail. Spoke the Concord	2	151
	21	Foggy in a. m. Anchored and set gear. Clear p. m. Up anchor and stood to the westward	1	50
	22	Very fine. Sailed to the westward of Patrick's Fiord and set gear	1	......
	23	Under way and ran to the eastward. Very moderate off Ise Fiord	1	......
	24	Very moderate. Ran by Cape North, bound easterly. Spoke the Alice M. Williams	......	......
	25	Very moderate. Anchored off Skaga (?) Point and set trawls. Wind easterly	1	56
	26	Very moderate westerly wind. Under way all day	1	56
	27	Anchored at Grimsey.‡ Set under sail. Wind west	1	103

*Captain Ryan tells me that he got under way and shifted a berth every day, though this is not always noted in the log-book.

† The storm was probably at its height before it was time to begin fishing in the morning, but Captain Ryan says it blew fresh, and was very nasty and disagreeable weather all day. It could not, however, have blown a gale or anything like it during the greater part of the day, for it is evident, from the fact that two sets were made and 240 halibut taken, that fishing operations were not interfered with. The prevalence of a *gale*, in the ordinary acceptation of the term, particularly among fishermen, would have prevented all fishing.

‡ The "Grimsey" alluded to above by Captain Ryan, he tells me, is a small rocky island that is frequented by large numbers of sea birds, chiefly gulls, eider ducks, sea pigeons, murres, and a few other species. In this connection it may be stated, on the authority of Captain Ryan, that hagdons (*Puffinus*) are very scarce about Iceland, only two birds of this kind having been seen during the entire summer. Mother Carey's chickens do not occur there at all, not a single one having been seen. Sea geese (*Phalaropes*) are abundant, and also paraquets. During the month of July the murres hatch out their young (one to a pair of birds), and until the nestlings are able to go out to seek their own food the old birds may be seen in the morning leaving the land by the hundreds and flying off to the fishing ground,

Date.		Entries.	No. of hauls of trawls made daily.	No. of halibut salted each day.
July	28	Very moderate. Anchored and set trawls. Up anchor and set at Grimsey Island	2	126
	29	Windy from southeast. Anchored at Grimsey Island	1	65
	30	Very moderate. Got under way, stood on the fishing ground, anchored and set	2	176
	31	Fine, clear, and moderate	2	206
Aug.	1	Very fine and moderate. Shifted berths. Spoke the Concord	2	234
	2	Foggy in a. m., windy in p. m. Anchored at Grimsey Island and filled water	1	81
	3	Very stormy; easterly wind. Laying at anchor at Grimsey Island	......	......
	4	Easterly storm continues. Still anchored at Grimsey Island. Got under way, but anchored again	......	......
	5	Northeast wind and foggy. Up anchor and set under sail. Anchored in p. m. and set	2	30
	6	Foggy in a. m., with northerly wind. Up anchor and shifted a berth	2	170
	7	Windy from southeast. Got under way, and anchored again at Flatty Island	1	53
	8	Very fine, moderate, and clear. Anchored on fishing ground and set gear	2	197
	9	Very fine and moderate. Off Flatty Island. Filled water	2	125
	10	Windy from the southeast. Made two sets under sail	2	100
	11	Very fine. Under way all day; sailing westerly	......	......
	12	Very fine. Anchored and set. Up anchor and got under way on Skaga Bank	1	19
	13	Disagreeable weather; foggy, with easterly wind	2	253
	14	Fine weather, with variable winds. Up anchor and shifted a berth	2	139
	15	Moderate, with rain. At 4 p. m. weather fine. Up anchor and shifted a berth	1	115
	16	Southerly wind and fine weather. Shifted a berth. Got under way at 7 p. m.	2	168
	17	Under way standing to the westward. At 10 p. m. came to anchor in Ise Fiord	......	......
	18	Took on board all barrels previously landed, and filled water	......	......
	19	Took salt on board that had been landed	......	......
	20	Wind northerly. Got under way and came out of Ise Fiord	......	......
	21	Very windy from southwest. At 8 p. m. anchored on Skaga Bank	......	......
	22	Strong southerly wind. Barometer, 28.80	1	148
	23	Moderate easterly wind. Strong tide on Skaga Bank	2	171
	24	Fine weather and moderate. Old [ground] swell on Skaga Bank	1	45
	25	Fine and moderate. Got under way and stood to the westward. Off North Cape in p. m	......	......
	26	Homeward bound. Heading to the westward with a strong SSW. wind. At 4 p. m. reefed sails	......	......
	27	Very moderate in a. m., with heavy swell. At 4 p. m. made sail. Wind northeasterly	......	......
	28	Very moderate; variable winds	......	......
	29	Moderate southerly wind, with rain showers	......	......
	30	Moderate in a. m. Strong east wind and rain showers in p. m	......	......
	31	Fine and clear, with northwesterly wind. Moderate in p. m	......	......
Sept.	1	Easterly wind, with showers	......	......
	2	Strong southerly wind, with rain. Reefed sails in p. m	......	......
	3	Westerly gale. Hove to at 6 a. m	......	......
	4	Made sail at 3 a. m. Strong northerly wind	......	......
	5	Southerly wind, with rain, in a. m. Changed to westerly in p. m	......	......
	6	Strong easterly wind, with fog and rain	......	......
	7	Strong easterly wind in a. m. Moderating at 4 p. m. Sighted the Newfoundland coast	......	......
	8	Wind NW., with clear weather. At noon passed Baccaliue Newfoundland. Saw numerous icebergs	......	......
	9	Wind WNW. At 4 p. m. passed Cape Race, N. F	......	......
	10	Wind moderate and changeable in a. m.; northerly in p. m. At 5 p. m. off Cape Pine, N. F	......	......
	11	Moderate in a. m. Wind breezing up from SSW. in p. m. Moderate gale at 6 p. m	......	......
	12	Wind westerly. Heavy swell. At 1 p. m. made Cape Canso	......	......
	13	Wind NNW.; fine and clear. Passed Cape Sambro at 7 p. m	......	......
	14	Wind NNW. Passed Cape Sable at 10 a. m	......	......

from which they return soon after, carrying lant in their beaks to feed their young. About the beginning of August the young murres take to the water. At first they cannot dive, and are cared for with the utmost solicitude by their parents. Captain Ryan tells me that the old birds, when they find a vessel is approaching them and their offspring, make the most desperate efforts to protect the yet feeble fledgling, and show their anxiety and concern by keeping up a continuous screaming. He tells how, on one occasion, his vessel was approaching a pair of old birds, which had between them their little one. The frantic efforts of the parents having failed to get the young one far from the path of the vessel, one of the old birds rose to fly and made a desperate dash almost into the face of a man who was looking over the schooner's bow, and which the unhappy bird appeared to think was the enemy against which it must protect its young.

This closes the log. The vessel, however, arrived in Gloucester September 15, and soon after her arrival her fish were sold and her cargo was discharged.

The David A. Story is 86.90 tons, and carried the same complement of men and dories as the other vessels that went on the same voyage. According to Captain Ryan, she weighed off 139,300 pounds of flitches, and had 56 barrels of fins; her gross stock was $7,600, crew shared, to each man, $220.

Captain Dago tells me that the French and English fishermen he met with at Iceland stated that the weather is exceedingly rough some summers on the fishing grounds of that region, so much so that they believed it would be entirely impracticable to carry on fishing in boats. He was also informed that fishing operations are sometimes interrupted by the floe-ice that is driven on the coast. Such an instance occurred a few years ago, it is said, when the entire fleet at Iceland was kept confined in port for several weeks, by a large mass of floe ice that drove on the coast, completely blockading the harbors and preventing the vessels imprisoned therein from moving in any direction. Such occurrences are, I believe, somewhat rare. And it is altogether possible that future investigations may result in the discovery of halibut grounds on parts of the Icelandic coast where fishing may be prosecuted even when the northern part of the island is beset with ice-floes.

For the purposes of comparison it seems desirable that a statement should be given of the halibut catch at Greenland this year, in order that we may arrive at correct conclusions regarding the value of the fisheries at Iceland, and estimate intelligently their importance.

The figures given below of the Greenland catch are approximations only—or rather round numbers—but are sufficiently accurate for the present purpose. The statements concerning the localities fished in, the time employed in Davis Strait, &c., are based on information gathered from Captain Byron Hines and others who were engaged this summer in the halibut fishery at Greenland.

The schooner M. H. Perkins, of Gloucester, had a fare of 83,000 pounds of flitches caught off Gothaab; and the schooner Herbert M. Rodgers, of Gloucester, caught 73,000 pounds of flitches off Gothaab. These were the two earliest arrivals from Greenland. The schooner Byron, of Pubnico, Nova Scotia, had a fare of 74,000 pounds of flitches taken off Gothaab. Captain Hines, her skipper, says he fished at Greenland from June 28 to September 4. The vessels, he tells me, were prevented from fishing south of Gothaab, owing to the presence of large quantities of drifting floe-ice. He states that all of the Greenland fleet reached the fishing grounds in Davis Strait about the same time that he did, namely, near the last of June. The vessels were allowed to land material this summer without interference from the authorities, but the fishermen were informed that hereafter they would not be permitted this privilege which they have heretofore always enjoyed. The

Danish authorities also object to the employment, on board of American or British vessels, of the Eskimo; and natives that were on board of the Byron and Herman Babson, the latter of Gloucester, were taken out of those vessels by a Danish war steamer.

The schooner Herman Babson brought home about 60,000 pounds of flitches. The schooner Mary E., of Gloucester, took 50,000 pounds of flitches off Cape Amalia, and the schooner Mist, of the same port, brought in about 70,000 pounds of flitches from the Cape Amalia ground.

It will be seen from the foregoing that the vessels that went to Iceland averaged more than double the catch of those which resorted to Davis Strait, and it is reasonable to assume that the Iceland fleet may be much larger next year than it was during the past season.

GLOUCESTER, MASS., *September* 24, 1884.

XXI.—THE FISHERIES OF ICELAND.*

By Aug. Garde.

The board of directors of the Danish Fishery Association had kindly given its consent to my visiting Iceland during last summer for the purpose of examining the Iceland salmon fisheries; and the Assembly of Iceland (*Alting*) furnished the necessary funds. My position as secretary of the association of course made it my duty to take notice of everything pertaining to the fisheries, wherever it was possible during my journey, in order to repay the association in some measure for its kindness in having the daily routine work of the secretary's office attended to during my absence. As my principal object, however, was the investigation of the salmon fisheries, and as therefore my travels in Iceland took me away from the coast, I could not expect to have much chance to observe the sea fisheries, which form one of the principal sources of income in Iceland, and in regard to which it has been said that if properly managed they would yield as much income as the entire revenue of the Danish butter and lard trade. I must confess that I went to Iceland with the idea that all that could be seen of the Iceland fisheries during a short stay would be comparatively well known, so that in this respect I would scarcely be able to bring home any new information. I am obliged to state that, both in respect to the fisheries and nearly everything else concerning Iceland, I was greatly mistaken. I had not been long in Iceland before it became clear to me that in Denmark we have a great many erroneous ideas concerning this island. We generally imagine Iceland to be a disagreeable and poor country, where it is hardly possible to live with any degree of comfort. I can assure my readers that this is a mistaken notion. It should be remembered in what part of the globe Iceland is located, and that a vast distance separates the Copenhagen Exchange from the Iceland markets. I think that most people in Denmark know very little about the Iceland fisheries, their importance, and their future possibilities; which fisheries, if properly developed, would greatly benefit not only Iceland but also the mother country. It was not long, therefore, before I realized that even a cursory examination of the Iceland fisheries would furnish additional important information to me. I therefore intend to give some brief account of my experience.

* "*Islandske Fiskerier.*" From *Fiskeritidende*, No. 50, Copenhagen, December 9, 1884. Translated from the Danish by Herman Jacobson.

The location of Iceland and its numerous fiords, penetrating far into the country, both in the west, north, and east, make it a home for a population whose principal source of income must be the fisheries. The sea around Iceland is particularly rich in fish, and it must be considered a low estimate when the extent of its fishing banks is stated to be 1,000 square miles, or about one-half as much as the entire area of the island. The fishing grounds around Iceland are probably much larger, as they extend all around the island and for many miles out to sea. All that is required is to find the fish in the right place and at the right time. It is not necessary to stay long on the coast of Iceland before one discovers that an exceedingly productive sea washes these shores. The water literally swarms with animal life. The fish which are brought on shore are fat and of very fine quality, and close up to the coast there are fish which form an excellent article of food. It is, therefore, not surprising that foreign nations, including France, England, and Norway, take a share in the Iceland fisheries. During the present year (1884) even the Americans visited the Iceland waters, as two schooners came from the well-known fishing station of Gloucester in order to catch halibut. The manner in which the Americans take hold of such matters is well illustrated by the expedition of these two schooners. When one of the American commissioners to the Berlin Exposition of 1880 went home he paid a visit to England, and was informed by English cod fishermen that they often caught large quantities of halibut near Iceland. This information drew the attention of the Americans to Iceland, as salt halibut is much sought after by the smoke-houses; and if matters really were as the Grimsby fishermen stated, it would be much more advantageous for American fishing vessels to visit Iceland than the west coast of Greenland. At the London Exhibition of 1883 the Americans found this information confirmed, and the consequence was the immediate dispatch of the two schooners to Iceland. When I was in the southern part of Iceland it was known that the American vessels had arrived, but it could not be ascertained what success they had met with. In the middle of August the two schooners had not yet returned to Gloucester, which was considered a good sign, as they certainly would have returned long since if they had caught few or no fish. I have called attention to this determined way of engaging in a new enterprise, which contrasts so strongly with the slow development of the Danish sea fisheries.

The great fisheries near Iceland have for their object principally cod, herring, and sharks; and it is particularly cod and herring that attract foreign fishermen to these waters. Besides these fish, whales and halibut are caught. The Icelanders also catch lump-fish, flat-fish, and other small fish; and in the fresh waters considerable salmon and trout fisheries are carried on.

The cod fisheries are the most important of all the Iceland fisheries. The catches of large codfish form the basis of the entire trade in salt

and dried fish; and it is this which principally attracts the foreign fishermen. From March 1st till some time in May, and during winter, the large codfish come near the shore, while during the rest of the year they go out to sea, so that the vessels have to go from 4 to 12 Danish miles [18 to 56 English miles, about] from the coast in order to find them. As a general rule, the Iceland fishermen are not prepared to catch large codfish except in the neighborhood of the coast. Their condition is about the same as that of the fishermen on the west coast of Jutland; and, like these, they must return to their homes the same day. Neither of these two classes of fishermen can be blamed for this way of carrying on the fisheries, as natural conditions compel them to follow this method. None of these fishermen have a suitable harbor; but they are obliged to pull their boats on shore, and often the breakers prevent them from going out to sea. It should also be held in mind that the winter fisheries of the Icelanders are carried on during a season when there are only a few hours' daylight every day. The fishermen must go out to sea early, so they can get to work when the short day breaks; and many a time they are out at sea fishing by the weak light of the aurora borealis. The same causes which compel our West Jutland fishermen to use open boats are also met with in Iceland; but there is this difference, that the Icelanders could find many places where their vessels could lie sheltered if they possessed such vessels. The Iceland fishermen are generally too poor to get anything but open boats; and, for this reason, many a good day's fishing on the open sea is lost to them, and the number of their fishing days is greatly diminished thereby. Much time is also lost in rowing out to the fishing place, and by the poor fishermen getting wet and hungry. The lot of the Iceland coast fishermen is a hard one. They take out little or no provisions, and it often happens that they have to go without food for more than 12 hours. Now the Icelander can go without food for a long time, but he can also do full justice to a meal when he gets it.

I will not now describe the migrations of the fish in the waters around Iceland, nor will I speak of the coming of the fish at the different seasons of the year, the methods of fishing, the boats employed, &c.; but I must state that the development and, in fact, the future of the Iceland cod-fisheries depends principally on the possibility of increasing the number of larger and decked vessels. When such a vessel is well commanded and has a good crew it can earn about four times as much as an open boat. The best illustration of this condition of affairs is furnished by the circumstance that while the French fishermen every year catch about 25,000,000 pounds of fish near Iceland, the Icelanders themselves catch only about 22,000,000 pounds; and the 100 vessels sent out every year by the city of Dunkirk, France, bring home about as many fish as Iceland exports. Each French vessel catches about $6,432 worth of fish per annum.

As regards the pay of the fishermen on the Iceland vessels, we pos-

sess some data, furnished by Mr. Th. Egilson, of Havnefiord, and published in 1882 in the *Nationaltidende*. From these data it appears that each fisherman gets about one-half of the fish which he catches. But it is also the general custom that the fishermen get in addition all the halibut and other fish which they may catch. Of the codfish and haddock the fishermen get one-half, while the other half goes to the owner of the vessel. In the beginning the owner furnishes the salt, but later the fishermen have to buy their own salt. About 10 bushels of salt are needed for 320 pounds of klip-fish. With the exception of dinner, which the owner provides, the fishermen must furnish their own meals. During the fishing season, which lasts about three months, the following is used for a crew of 10 or 12 men: 4 bushels peas, 4 bushels barley, and from 40 to 60 pounds rice. The owner gives the crew hot coffee three or four times a day. The captain gets one-half of all the codfish which he takes, and keeps all the other fish which he may catch. He is boarded entirely by the owner, and gets 53 cents premium for every 100 codfish caught by his vessel. He is also furnished with salt for his share of the fish. The mate has free board, and is in other respects situated the same as the captain, with the exception that he receives no premium and gets only one-half of the salt which he needs. The cook gets free board, $2.14 per month, and one-half of all the fish he catches.

The herring fisheries of Iceland are of comparatively recent origin. It had long been known that herring of excellent quality were found near Iceland, and some Norwegian vessels had for several years made vain endeavors to make a good catch, when suddenly success crowned their efforts some years ago, and immense herring-fisheries sprang up in several of the Iceland fiords. The Iceland herring is large and fat, and is in great demand. In olden times an Iceland herring was a great delicacy in Denmark, and as much as 80 cents was paid for one. The Norwegians did a good business, as the herring cost them only from $2.14 to $2.68 per barrel, while they sold them at $6.70 and upwards per barrel. Of the herring associations existing in Iceland, the Icelanders themselves take part in 6; and 2 are exclusively composed of Icelanders.

The Iceland herring-fisheries, however, shared the fate of all fisheries; *i. e.*, they had their ups and downs. This year, for example, the herring fisheries in the Iceland fiords were not very productive, and the Norwegians sustained considerable loss, by lying out at sea for months, and waiting in vain for the coming of the herring. People are inclined to ascribe the failure of a fishery to excessive fishing. This assertion is frequently made in Denmark, and the same story now comes to us from Iceland. As soon as the fisheries are less productive, or as soon as the fish become scarce in the market, it is said that excessive fishing drives the fish away, or has begun to exterminate them. But if we consider the extent and depth of the Iceland fiords and the wealth of animal life found in them, not even counting in the vast sea outside the fiords, we are compelled to own that some other cause than excessive fishing

must have occasioned the failure of the fisheries. We possess statistics of the Iceland fisheries going back several centuries, and we find that at all times there have been ups and downs. But is there any difference in this respect between fisheries and agriculture? In the course of years there is a constant alternation of good, medium, and bad harvests; and it will be generally acknowledged that climatic changes are the principal causes. The same applies to the fisheries. The weather exercises an influence on the animal life of the sea, and on the facilities for fishing. Unfavorable weather may in one year destroy partly or entirely the eggs of the fish and greatly interfere with spawning, or even destroy many of the young fish; then again there will be years when hardly any fish are caught, and such a year will long be remembered. It may also happen that the spawning and hatching processes pass off successfully, but that the young fish perish, because from some cause the food on which they depend has been destroyed. Poor fisheries are, as a rule, caused by natural hindrances, such as the condition of the weather and of the sea. I consider it impossible to determine beforehand, in waters like the Iceland fiords, what amount of fish will be caught; but I think that more knowledge should be obtained of the natural condition of those waters, with special regard to the fisheries and their needs. Everywhere endeavors are being made to obtain such knowledge; and in all cases the object is the same, namely, to obtain such a knowledge of the conditions of life of fish and of the physical conditions of the sea, as will enable fishermen to pursue their trade with some understanding, and not to work in the dark, as is unfortunately done so frequently. At present the Iceland herring-fisheries are a sort of lottery, which probably in the course of years yields but small gains to the ship-owners who every year send their vessels to Iceland.

The shark fisheries, more than any other fisheries, are peculiar to Iceland. Their results are more uniform from one year to the other; and they must, on the whole, be considered remunerative. The principal object is to get the liver of the shark, which contains a great deal of oil. Some time ago I gave a full description of these fisheries, and it will therefore not be necessary to say anything about them in this place.

The whale fisheries are not carried on systematically by the Icelanders, and no Danish vessels are engaged in them. Occasionally a whale is thrown on the Iceland coast; and it even happens sometimes that a whole school are locked in the ice, and are killed or else perish. Thus a few years ago 40 large whales were caught on the property of one man in Nordland. During the last few years the Norwegian whaler Sven Foyn has maintained a whaling establishment on the coast of Iceland. Last year these fisheries were not very productive, and there was some talk of closing the establishment; but this year about 25 whales were caught, worth from \$16,000 to \$21,000. Whale fishing is

not very popular in Iceland, as people have an idea that the whales chase the fish from the open sea towards the coast, and thus benefit the fisheries. The objection might be advanced to this theory that in poor years for fisheries the whales must be idle. It seems that the Icelanders cannot understand why foreigners should reap the benefit of the fisheries in these waters; and the idea seems to prevail that the whale fisheries contribute their share towards chasing the fish from the coast and driving them far out to sea. I think that in this respect the Icelanders are very much mistaken. What does the catching of 25 whales during a period of six months amount to? That would be about one whale per week. I cannot imagine that, if in the little Kallundborg fiord (in Denmark) a whale was killed every week, the fish would be chased away thereby.

The halibut fisheries are principally of importance only to the Icelanders themselves. These fish do not seem to meet with much favor in England, and attempts to introduce them, salted, into the Danish markets have not proved successful, another instance showing how difficult it is to induce the public to take to a new article of food. For the Icelanders the halibut is of great importance, as dried halibut is to them what wheat bread is to us, while other dried fish correspond to the common, every-day rye bread. I must admit that dried halibut with good fresh butter is a very savory dish, and fully as digestible as our dark Danish rye bread. For my own part I would gladly exchange all our cakes for the inviting and finely-flavored dried Iceland halibut. The lump-fish is smoked by the Icelanders, and as it forms a favorite article of food with them and keeps for a long time, it is much sought after.

In the fresh waters of Iceland salmon and several kinds of trout are caught. The salmon is the most important of these fish, and might be made still more valuable to the Icelanders. At present it is almost impossible to ship the Iceland salmon fresh because it is difficult to get ice to those places where it is needed. The salted salmon is not cured in such a manner as to give it a general sale. The Iceland salmon and trout fisheries are on the decline, because the fisheries are carried on during the wrong season, and because the seals are protected to the detriment of the salmon; the Iceland rivers are moreover soon exhausted if fishing is carried on to an excessive degree. In the lakes, however, there are considerable trout fisheries.

The question may well be asked whether the Danish fisheries near Iceland, and the fisheries carried on by the Icelanders themselves, have any future. I am of the opinion that the question can be answered in the affirmative. But I do not think that the matter should be taken hold of in the same manner as was done in 1865, when a plan was under discussion to start a joint-stock Iceland Fisheries Company, with a capital of $268,000 and about one hundred vessels. When it came to the point, the capital and the number of vessels were put down much lower; but the great mistake was that people here in Denmark thought that

the whole battle was, so to speak, to be won by a single stroke, whereas it certainly requires considerable time to start an enterprise like this. Such a matter should be taken up slowly and deliberately. In this manner some Danish fisheries have already been started near Iceland, and gradually a considerable number of vessels visit Iceland every year, and the fisheries carried on by them have on the whole paid well. I do not desire to pass any criticism on these efforts, but I must say that in fitting out a vessel for the Iceland fisheries it is of greater importance to engage the right kind of men than to haggle about the wages, as some of the men who have engaged themselves on Iceland fishing vessels have not been sailors, much less fishermen. In view of the rich hauls which may be made in Iceland waters the object is not to save something on the men's wages, but to secure experienced and active fishermen, on whom, after all, it will depend what the results of the fisheries will be. It is somewhat of a hardship to go out with an Iceland cod or shark vessel; the crew should, therefore, be treated well. A poor crew will also get poor treatment. The crews of some of these vessels are composed of all sorts of people, some of whom know very little about fishing. Vessels having competent crews invariably bring home the most fish, and the reverse is the case with those vessels which have poor crews.

We have heard so many complaints that the Danish fishermen, as a rule, live in very poor circumstances. Unfortunately this is but too true, for it is well known that a fisherman's family, whose principal source of income is fishing in Danish waters, earns on an average only from $134 to $160 per annum, and even less in some parts of the country. As long as we have no good harbors on the west coast of Jutland, and as long as it is difficult to find a market for the fish caught on that coast, it seems perfectly proper to encourage our young fishermen to go to Iceland, and to recommend our sailors, who frequently cannot find anything to do at home, to seek employment in the Iceland fisheries, where there is a constant demand for skilled sailors.

More remains to be done for the Iceland fisheries than for the Danish fisheries. In the first place, it should be remembered that many Iceland fishermen have to solve a twofold problem: They are to furnish food for themselves and for the population of Iceland, and they are at the same time to prepare an article for which by bartering they can obtain what they need. Nor should it be forgot that many a farmer turns fisherman during a part of the year, while during the remainder of the year he gives his whole attention to farming. All these causes combine to render the Iceland fisheries, as carried on by the Icelanders themselves, comparatively unprofitable, simply because they are not properly developed. The reason why the Iceland sea fisheries do not flourish is that labor is scarce. The Icelanders begin to emigrate; they should rather encourage immigration to their country. The Icelanders are justly displeased to see foreigners come to their shores, earn con-

siderable money, and go home again without spending anything in Iceland. The Icelanders should encourage foreigners to come to their shores, not only on a visit, but to settle there. This could easily be done by giving employment to foreign fishermen who would consent to stay in Iceland for some years and try their fortune. Iceland is by no means such a terrible country to live in as is sometimes made out; and skilled fishermen will certainly have a chance to make money.

The Iceland fishermen have but little knowledge of navigation, and it is a very rare thing to find an Icelander as captain of a sea-going vessel. Why does not the Iceland government establish a school of navigation at Reykjavik, perhaps in connection with a school for fishermen? This should certainly be done. The Iceland government should do something to promote the fisheries, as by forming an Iceland whaling company, by establishing a guano factory, by endeavoring to introduce lobsters in the Iceland fiords, &c.

Denmark might cause a cable to be laid between Iceland and Norway, and have the Iceland waters properly examined and surveyed and good maps of the same published.

XXII.—EXTRACT FROM THE REPORT OF A. ANNANIASSEN ON HIS VOYAGE TO ICELAND.*

MANUFACTURE OF KLIP-FISH.

a. As soon as the fish are taken from the water, and while they are still living, their throats are cut.

b. After the fish are split they are placed immediately in the sea and washed with a brush, and the blood and the black peritoneum are carefully removed. The washing is done entirely in salt water, and the fish are not salted until most of the water has been drained off.

c. The method of splitting is exactly like the Scotch and Faroe Islands methods. The portion of backbone remaining in the flesh by these processes is left in the opposite side to that which obtains in the Norwegian system; from 18 to 22 vertebræ are left in, according to the size of the fish. The backbone is cut obliquely across one or two vertebræ. The splitting-knives (*rungknive*) are of English manufacture, having a thin blade somewhat rounded at the point.

d. After the fish are washed they are left to drain for one hour, so that the water may run off, after which they are salted. Liverpool salt is used for the most part in Iceland, one barrel of salt being employed for about 100 large fish, which may be estimated to weigh 1 *skippund* (320 Danish pounds) in the dried state. If, however, the fish are smaller, a barrel of salt is required for such a number of fish as will weigh 1 *skippund* in the dried condition; this number may vary from 100 to 160 fish, and the man who does the salting must be accustomed to estimate the number of fish required. The salting is done in heaps, without any fixed height, varying only according to the capacity of the shops or salting houses. After the fish have remained salted thus for two or three days, they are relaid in a similar pile with the addition of a very little salt, about one-eighth of a barrel to the *skippund*. After they have remained thus for some time they are ready to be washed previous to drying, the washing being carefully done in salt water with a brush. If, however, it should be so late in the fall that the drying must be deferred until the following spring, the fish are left in their first salting, and in that case sufficient salt is used so that no fish may

* From *Selskabet for de norske Fiskeriers Fremme, Aarsberetning* 1883, pp. 3–10. Translated from the Danish by TARLETON H. BEAN, M. D.

come in contact with another. In the spring the fish will be of the same quality as if they had been caught the same year. They make, as far as I am aware, no difference in salting between the fresh fish and those that remain over. There is no salting in vats (*kar*), but bins or heaps are everywhere used. The fish which are caught in the fall, and which cannot be dried the same year, are always thoroughly rinsed and washed clean of blood before they are salted, and the black membrane is removed, just as when they are washed for drying. I observed that after the resalting of the fish is finished, all the salt which is not taken up by the fish is again mixed with the fresh salt, and in this manner is used many times. After the fish are washed out they are laid in small bundles or heaps. The fish are all laid in the same way, and remain lying in this position until the water has drained off and a little stiffness is perceived in them. If there is an opportunity the next day to get at the fish for drying, it is improved. In the opposite event the fish are laid in square heaps, which contain not more than 100 to 150. In case there should be no drying weather upon subsequent days, the fish are repiled daily. After one or two days of drying the pressing process begins, and this is repeated successively as the drying progresses. When this process has advanced to the stage in which the final pressing is about to take place and the fish are collected into larger piles of about 20 *skippund*, these are covered with mats, and boards are placed on top of them in the form of a roof. Then on the top of this is laid a thickness of stone equal to that of the fish in the pile, this method of pressing being universal. The fish remain under this pressure four or five days, and, if the weather allows, they are laid out again after this time; but immediately upon being collected again they are weighted with the same pressure. If the weather should be unfavorable for any further drying after this time, the fish are repiled daily and weighted constantly with the same pressure until they are dry.

The principal difference between our mode of drying and the Icelandic method is that the pressing process contributes most largely to the drying of the Iceland fish. The sun is seldom so warm in Iceland as to injure the fish, but this may sometimes happen.

e. The drying place consists of cobble-stones, which are for the most part artificially laid. Boards and twigs are also used to some extent. The advantage of the Icelandic drying place is that the air circulates above as well as below.

The reason that the Icelanders press their fish so much more than we do is to be found, first, in the fact that the fish are salted more, and, secondly, that there is more cloudy weather and less sunshine, so that they hasten the drying by constant heaping and the necessary pressing; a third reason is that the fish are fatter and thicker, and therefore endure more pressing than ours do.

Dried fish are usually one-half lighter than fresh fish, and, if the fish are very fat, they weigh perhaps a little less in proportion after drying.

When dried fish are made from salted fish, the dried product is generally one-third lighter than the salted fish from which it was prepared.

f. After the fish are dried they are brought into small store-houses and placed in large heaps, just as in Norway. Most of the store-houses in Iceland have a frame-work of posts, covered outside with boards and partly wainscoted within. They consist of a single room, and the fish are usually piled quite up to the roof, if there are enough of them. Each heap is always covered with mats or sail-cloth, as the air here is very moist, and, since the fish are strongly salted, moist air may easily penetrate and injure them.

g. Besides cod, a great many haddock, of which a considerable number are caught off the coast of Iceland, are used for klip-fish, and they are handled in just the same manner as cod. On the other hand, ling (*Brosmius*) are less common, but they are also sometimes prepared in the same manner. The wolf-fish and halibut are also split, salted, and dried as klip-fish, but they are used exclusively for home consumption.

h. Of the refuse portions of the fish very little is used. The heads are dried to some extent and used as food, both for men and other animals, but the greater portion is thrown away as useless. The air-bladders are also sometimes used. As soon as they are removed they are carefully washed in salt water to remove the blood and the black skin. They are not salted in vats or bins until most of the water has been drained off. As a rule, sufficient salt is used to make a strong brine. There is, however, no fixed time during which the fish must remain in pickle. When they are taken out of the salt they are again washed in salt water, and the black skin which then appears is peeled off. Afterwards they are hung up by strings, and dried by hanging them on the sides of the houses. They are used almost entirely for home consumption, and rarely as an article of commerce.

i. No fish which are prepared by the people of Iceland as klip-fish are pickled in barrels.

j. The principal market for the Iceland fish is Southern Spain, but many of the Iceland traders send a not inconsiderable quantity to Copenhagen, consisting for the most part of salted and moist fish. On the other hand, while dried fish are sent to Spain, no further assorting takes place for the trade, as far as I know. Haddock are sent both to Spain and to Copenhagen.*

k. The difference between the winter fish and the summer fish is that the winter fish are usually larger and comparatively fatter than the summer fish.

l. Fish caught with the hook are as a rule the best fish in Iceland, because they are always bled and are quickly salted. The mode of drying is the same for all klip-fish.

m. The liver is small and contains very little oil. From 1,000 to

*A large number of small fish are also sent to Great Britain.

1,500 cod furnish one barrel of livers. The haddock generally has a larger liver than the cod.

MISCELLANEOUS NOTES.

1. The Iceland fishermen use for the most part small boats, accommodating from 3 to 5 men, and generally fish with long lines in the fiords. When not much bait is at hand, they fish also during favorable weather, at a distance of from one-half to one mile from the shore, with hand-lines. At Westmanerne larger boats are employed, having a crew of 8 to 11 men. The fishing from this place is carried on, with long-lines and hand-lines at a distance of from one-half mile to one mile at sea. The people of Iceland also employ small sloops in the cod fishery, generally off the coast, but to some extent, also, within the fiords. They use hand-lines exclusively.

2. The fishing in Iceland begins in the month of March with the so-called spring or winter cod. It begins on the south coast at Westmanerne and off Reykjavik, and is prosecuted by the inhabitants of these localities in boats, sloops, and smacks, but most of the fishing is done by French fishermen. It continues to the beginning of May. Most of the fishermen thereupon go to the west coast, to Isafjord, Bredebugten, Arnafjord, and Patrikfjord, where the fishing, as a rule, is at its best in the months of May, June, and July; continuing, however, through the whole year, except when bad weather and ice prevent. In the middle of August and during the remainder of the autumn, when the herring come into the fiords on the east coast, there is excellent fishing in the fiords. So far as my information goes, the best fishing places are Seydisfjord, Eskefjord, and Ofjord, on the north and east coasts, and on the west coast Isafjord and the fiords in the vicinity.

3. The Iceland boat-fishermen consist, for the most part, of vessel-owners who prosecute fishing with the help of servants hired by the year. Some of the boat-owners co-operate and fish on equal shares, with the exception of the foreman, who has a percentage of the fish, ranging, according to agreement, from 20 to 25 pounds in each *skippund* of dried fish. Again, some employ boatmen, usually by the day. Sloop-fishermen, on the contrary, are engaged for a specified time and generally receive half of the catch of fish, and all their expenses, but sometimes only one-half of their expenses. The people live chiefly upon English *kjax* or bread, which is imported; sometimes, also, they have butter prepared from sheep's milk. They use, besides, a great quantity of whiskey, which they nearly always have in their possession. Finally, they have coffee, which is a universal drink.

4. The fishing boats of the Icelanders, according to my opinion, are very unsafe and unreliable, since they are round-bowed and cranky, and carry only a mast with a rude sail, which is seldom useful in sailing with a strong breeze.

5. The implement for the cod fishery is the long-line similar to our

own. Number 7 hooks are used, and the distance between them is from 6 to 7 feet. Long-lines are always set on the bottom, and glass floats are not used. The buoys are Scotch. They use on the hand-lines a lead in the form of a hand-lead, through which is bored a hole wherein is placed a wire about two feet long, one on each side of the lead. On the ends of the wires sticks are fastened, on the ends of which are placed larger hooks, and in the middle smaller ones. Each hand-line thus has at the most four hooks.

6. Herring are used for bait whenever they can be obtained; in the absence of these, wolf-fish and halibut are preferred, mussels also being used to some extent, and occasionally lug-worms (*Arenicola*). The last kind of bait is used mostly on the west coast.

7. The stomach contents of the cod are principally crabs and mussels; sometimes also smaller fishes of other species.

8. Cod fishing at Iceland with boats is prosecuted also by the Faroe Islanders. They send their boats over to Iceland on the mail-steamer and let them remain during the winter on the island. The Faroe people fish exclusively with long-lines, and are the best boat-fishermen at Iceland. They sell fish, for the most part, in the salted state. Besides French and English fishing vessels, of which there are plenty at Iceland, are found also some Danish and Norwegian craft, which always fish with hand-lines off the coast, but never nearer than 1 mile from the land. The Danish fishing vessels are accustomed to lie at anchor in August in the fiords and carry on long-line fishing with boats, which, as a rule, yields the best results, because at this time there is generally a good opportunity to obtain fresh bait.

9. My longest stop in Iceland was in Isafjord, and during that time I examined the larger fishing places here as well as at Bolongervig and Altafjord. As the mail-steamer enters most of the fiords and stops from six hours to two days in each, I next had a good opportunity to examine Westmanerne, Reykjavik, Eskefjord, Seydisfjord, Husavik, Ofjord, Siglefjord, Sudakrog, Skagestrand, and Reykjafjord, besides making a journey to Arnafjord. Thus I examined the drying-places in Iceland in the localities mentioned and collected information from the people concerning the mode of handling klip-fish and various other items concerning the Iceland fisheries. From the information which I collected in the different places, it appears that the method of handling fish is practically the same everywhere; but it results best in Reykjavik and thereabouts and in Isafjord, this being due to the more favorable condition of the weather during the drying season.

XXIII.—EXTRACTS FROM A REVIEW OF A. ANNANIASSEN'S VOYAGE TO ICELAND.*

By A. THORSTEINSON.

Mr. Annaniassen was sent to Iceland, in the summer of 1883, by the Society for the Promotion of the Norwegian Fisheries, in order to study the Iceland sea fisheries; and extracts from the report on his voyage, which was made during the months of June and July, are given in the annual report of the above-mentioned society for 1883.

He made his longest stay at Isafiord, where he visited the large fishing stations Bolungarvig and Alptafiord, at a time when the fisheries are not carried on with the same energy and results as during the principal fishing season, which comes earlier in the year. He also paid hasty visits to the stations where the mail-steamer calls, staying from six hours to two days; and thus had occasion to visit the Westmanna Islands, Reykjavik, Eskifiord, Husavik, Seydisfiord, Ofiord, Siglefiord, Sandarkrog, Skagestrand, and Reykjafiord. Owing to his short stay at each of these places, he was not able to collect complete data regarding the fisheries; and in respect to the curing of fish he could not make many personal observations, as the time was much too short and as the curing of fish has generally come to an end about that season of the year. He was not able to see the Iceland fisheries as they are carried on during the fishing season, except, perhaps, at Eskifiord or Seydisfiord, where there are considerable summer fisheries. He did not see anything of the important fisheries in the Southland and Westland, which, during the period from March 1 to May 14, furnish about three-fourths of the entire quantity of fish exported from Iceland. Owing to the season of the year at which he visited Iceland, therefore, and the shortness of his stop at the fishing stations, several mistakes have crept into his report. I aim here to point out some of these mistakes, make corrections, and show the true state of affairs. I will first make a few observations on the manufacture of klip-fish, following the lettering used by Mr. Annaniassen and omitting such divisions as call for no remarks.

* "*Hr. Annaniassens Rejseberetning fra Island.*" From *Fiskeritidende,* Copenhagen, December 23 and 30, 1884, and January 6, 1885. Translated from the Danish by HERMAN JACOBSON.

a. The fish are generally cut across the gullet and killed as soon as they come out of the water; but unfortunately this rule is not followed universally. On decked vessels the fish are generally killed by making a cut near the gills toward the neck, or else by making a small wound in the head with the point of the hook. This last-mentioned method is generally employed in the boat fisheries, and even a small wound will cause the fish to bleed to death.

b. After the fish has been cleaned it is always washed, but not with a brush, except, perhaps, on decked vessels; but even there a brush is found to be less practical than a common mitten.

d. Mr. A. is nearly correct when he states that a barrel of salt is used for 160 kilograms of dried fish; the quantity of salt, however, is rather less than more, but rarely less than 3 bushels. The quantity of salt used varies somewhat with the season, the quality of fish, the time they are to lie in salt, and according to their being salted in barrels, boxes, or simply in piles. Fish that have lain in salt two or three days are not piled up in new heaps, at least not in the Southland and in the Westland; although this may possibly be done on decked vessels. It is my opinion that this is done only on French and other vessels, where the fish are kept on board for some time.

It is scarcely correct to say that fish which have lain in salt during winter are just as good as those that have been caught in the same year or after new-year's. We shall come nearer the truth when we say that such fish make a tolerably good article.

After the fish have been taken out of the salt they are often piled up in large heaps; generally, however, small heaps are preferred. The smaller fish are put at the bottom with the skin downward, and so on, one on the top of the other, all except the bottom layer having the skin upward, so that each layer is pretty well covered by the one above it. When the heap is sufficiently high (from 7 to 10 layers), one of the largest codfish is laid on the top to serve as a cover. Many people, however, pile the fish one above the other, all turning the same way (that is, with the tail turned outside) in a long row, making about 20 layers or more. There can be no objection to this, even if most curers of klip-fish prefer (especially when there is prospect of rainy weather) to lay the fish in isolated heaps of from 7 to 10 layers, when it is of course not necessary to relay them. The statement that in case of rainy or unfavorable weather the fish are laid in square heaps and repiled daily must be regarded as an unsafe method, of which, however, I know nothing.

It is very difficult to lay down any rules for pressing the fish, as the varying circumstances of each case should guide in this respect. The same also applies to the relaying when the pressing becomes too lengthy a process; and it may, on the whole, be recommended to use less pressure. No relaying should take place unless there is danger of the fish fermenting. Pressing is used to smooth the fish and in order to dimin-

ish the moisture which is retained in the flesh after a crust has formed on the outside, and which, by pressing gradually, works its way toward the outside where it evaporates, but it does not contribute "most largely to the drying of the Iceland fish." Too much pressing in the beginning makes the klip-fish tough and less delicate in flavor. The pressure should never be so strong as to make the water ooze out from the pile of fish or to make it gather inside the pile. During drying care should be taken that the fish are changed every time they are pressed. Those which were on the top should the next time be at the bottom, and *vice versa*. When the drying process approaches completion the pressure is increased. Much will also depend, of course, upon whether the weather has been very dry or not. If the weather is unusually dry greater pressure is applied, so that the moisture may be distributed as rapidly as possible; and as soon as damp weather sets in the pressure is decreased.

e. It probably is not true that during the season for the manufacture of klip-fish (May 15 to June 30) there is more cloudy weather in Iceland than in Norway, and that the drying process is more hastened on account of this. Nor are the fish in Iceland salted excessively. The great pressure used in Iceland is applied solely to smooth the fish and to drive the moisture toward the outside, where it can evaporate more readily. I am not sufficiently acquainted with the Norwegian method of curing klip-fish to pass an opinion, but I am inclined to think that the principal difference between the Norwegian and the Iceland methods is this, that in Iceland the fish are dried, as a general rule, with more air and less sunshine. In Iceland the best places for curing fish are those where there is much draft and some sunshine, but not much, at least until the drying process is nearly complete.

When the fish have obtained a degree of stiffness so that they do not bend when taken by the tail and held upright, and when held against the sun or a strong light no dark portions are seen in the flesh, they are considered sufficiently dried. When they have reached this state the fish should be so firm that when pressed with the thumb or the points of the fingers no impression remains.

I have studied this question of the proportion of fresh, salted, and dried fish for some time, without arriving at an absolutely certain conclusion. The proportion named by Mr. Annaniassen may, however, be taken as approximately correct.

Until the year 1787, up to which time the fisheries were a monopoly of the Danish Government, I find that from the fresh fish about 25 per cent of klip-fish were obtained; and similar results are given in several reports from the eighteenth century. This cannot be supposed to be correct. I have been informed that in exceptional cases first-class fat sea-cod have given from 45 to 47 per cent of well-prepared dried klip-fish, while the usual percentage was 40, or more accurately from 38 to 40. Lean codfish, after the spawning season, and not very fat summer cod, will yield from 33 to 38 per cent, and in a few cases even less than 33

per cent. The highest percentage which, to my knowledge, fine fat but small summer cod have yielded, has been 42½ per cent, and often it has been less. On the south and west coasts of Iceland the spawning season is generally the first half of April, and during the principal fishing season (from March 1 to May 14) the fish will be of inferior quality for fully a month. It should be remembered also that the sea-cod which come near the coast vary greatly in quality, the difference as regards fatness often amounting to 33 per cent or more. The average weight of the sea-cod in the Faxe Bay is such that from 120 to 160 fish make a *skippund* (1 *skippund* = 160 kilograms = 352 pounds).

The Norwegian *Tidsskrift* (1884, p. 131) states that 100 kilograms of fresh fish yield in Scotland 39.3 kilograms of klip-fish; in Norway, 33.3 kilograms; in Newfoundland, 36.4 kilograms. On the strength of this statement I venture to express the supposition—while believing that this statement itself is also more or less only a supposition—that the average yield of klip-fish in Iceland is about 36½ per cent of the fresh fish, therefore about the same as in Newfoundland.

In the above-mentioned article in the Norwegian *Tidsskrift* an analysis is given of the klip-fish of different countries, among the rest of a well-dried Iceland klip-fish which weighed 1.5 kilograms, and is stated to have contained 5.4 per cent more water and 4.4 per cent more salt than a Norwegian fish. An analysis of one or two fish should be received with great caution, all the more as the quality of the fish varies greatly, and as the fish have often been in salt for a varying time. It must certainly be supposed that the fish which underwent this analysis had been in salt two or three months. The analysis of the Norwegian fish, moreover, was made in the place where it had been cured, while the Iceland fish had been shipped from Iceland to Norway. There is likewise little doubt that in a cargo of fish shipped to Spain changes take place which can be noticed very plainly, although we may not be able to explain them until an analysis of the fish has been made both at the place whence they are shipped and at the port where they are landed. As Spain is the principal market for Norwegian, French, American, and Icelandic fish, the analyses should be made there. In order that these analyses may be productive of reliable results, they should extend to a number of different specimens, and be made under the same conditions.

It is very difficult to state exactly the difference between salted and dried fish. Mr. Annaniassen states it to be one-third; but I am inclined to think that this is too low. From data which have been furnished me I think that it is from 37 to 39 per cent in sea-cod, and that it varies greatly. Lieutenant Trolle's figures (in *Fiskeritidende*, 1884, p. 132) are the lowest I have seen, namely, 28.2 per cent; but probably they relate to thick and fat small codfish, lightly cured for immediate consumption.

As regards some of these questions it will be exceedingly difficult to

arrive at any positive results which will serve as a basis for future calculations. As regards my statements I must say that they are based principally on the observations of other people, and that I had no means of ascertaining the special conditions under which they were taken. But considering the knowledge that I possess of the Iceland fisheries, I presume that they are tolerably reliable, and may under the circumstances deserve as much consideration as statistical data in general.

f. After the fish have been dried they are either kept in a pile under very light pressure, or if there is a large quantity they are placed in the house. If they are moist they should be laid for a short time in the sunshine before they are shipped.

h. The sounds or air-bladders of small fish are not used, because they have no value; but the sounds of the large codfish can always be used, and when properly dried they bring from 24 to 27 cents a pound. The usual treatment of the sound is not as stated by Mr. A.; but they are washed as soon as possible, cleansed from blood and all impurities, and are then spread out on the outside of the drying-shed where there is a good draft, or on stone fences, but so that they are not either in the rain or the sunshine. After they have become so stiff that they stay apart, they are drawn on strings and dried in the wind. The Iceland fishermen do not salt the sounds, nor should they be salted. If they cannot be dried immediately a little salt is sprinkled on them, they are soaked as soon as possible, and then dried in the usual manner. Only on vessels having a deck, and during rainy weather, are they treated in the manner described by Mr. A., and by this process a serviceable article is obtained, but by no means so good a one as when they are treated in the proper manner. To avoid the necessity of sprinkling the sounds with salt is a problem of great importance, and I am of the opinion that at the larger fishing stations and even on board the vessels suitable drying-ovens could be employed so as to obtain a really valuable article, such as the sound will always be when properly treated.

j. Those fish that are shipped to Spain are very carefully sorted over again. I do not know whether haddock are sent to Spain or not. The larger portion is sent to Great Britain or Denmark.

m. Mr. Annaniassen grants that the Iceland fish are fatter and thicker than the Norwegian fish; but he states that the liver of the Iceland fish is lean and does not contain much oil. Both in Iceland and in Norway the conditions under which the cod obtains its food vary greatly. Those fish which come to the banks from the ocean are generally very fat, but in some years they are lean. Their liver is generally of fine quality and contains as much oil as the liver of any codfish, furnishing excellent medicinal oil. Genuine fat summer codfish also have good livers. It is doubtful that haddock, as a rule, have larger livers than codfish, though this may be the case with many individual specimens.

I now pass to consider his miscellaneous notes, following his numbering and omitting the last, which has been referred to in the beginning of this review.

1. These statements are unreliable, being based on what was seen during the time of year when fisheries are not carried on very extensively, and on unauthentic information given in reply to his questioning.

2. In Iceland a distinction is made between the fishing season proper and other seasons of the year. During the fishing season, which lasts from March 1 to May 14, the fisheries are carried on with full energy and with all the hands that can be spared, many people who live inland leaving their homes to take part in the fisheries. During the other portions of the year fishing is carried on only by a few persons who are absolutely dependent on the sea for their living, or who occasionally go fishing, often simply for the purpose of getting a few fresh fish for their tables. The latter half of May and June the coast population is generally occupied in preparing klip-fish, digging peat, &c.; and during June and July many of them go farther inland to assist in the hay harvest. Farming and fishing go hand in hand in Iceland to such a degree that one must often give way to the other; and this is the reason why the summer fisheries are not carried on more extensively.

In most parts of Iceland the fishing season lasts two and one-half months (but never later than May 14), and furnishes the greater portion of the fish exported from Southland and the western fiords. Only of late years have there been considerable fisheries in the eastern fiords. Of the entire quantity of fish exported from Iceland during the four years' period, 1876 to 1879, inclusive, 44.9 per cent came from the south coast and the Faxe Bay; 39.7 per cent from the western fiords and Snaefellsnes; and 15.4 per cent from Northland and the eastern fiords. Along the entire south coast only large boats, with a crew of from 8 to 12 men each, are used during the fishing season. In the Faxe Bay, the Brede Bay, and the western fiords, besides the above-mentioned boats there are also employed smaller boats, with a crew of 6 or 7 men each; but this is only done in exceptional cases, when the fish come close to the coast. For the summer fisheries small boats, with crews of from 3 to 6 men each, are used almost exclusively. During the fishing season the codfish have often to be caught at a considerable distance from the coast, sometimes as far as 2 or 3 Danish miles [9 to 14 English miles], and even farther, as in the southern part of the Faxe Bay, where during summer I have often seen the fishermen go out as far as 4 Danish miles [about 19 English miles]; but of course when the fish are near the coast no one will think of going out any farther than is absolutely necessary.

3. As far as I have been able to learn, the food furnished to the Iceland fishermen is of good quality and sufficient in quantity. They generally, but not always, have some brandy with them when they go out to sea. Nor should they be blamed for this when we take into

consideration the fact that the crews on these Iceland fishing-vessels are generally small in number, so that it becomes impossible for the men to relieve each other as is done on the French vessels. But during the boat fisheries the fishermen very seldom have any liquor on board, even if they stay out at sea for a considerable length of time (12 hours or more). This is especially true among the Westland and Southland fishermen.

4. It is difficult to give a form or type of a boat which is in general use throughout the island. Even in localities which are adjacent the form of the boat varies considerably, according to the local requirements. Thus the boats used on the south coast, in the Faxe Bay, the Brede Bay, and the western fiords, resemble each other in some respects and differ in others. Each of these localities has some peculiarity as regards the build of the boat. In the Northland and Eastland the forms of the boats vary still more, as the fisheries in these parts have been developed only recently, and as, especially on the east coast, the fisheries are carried on by foreigners or by persons from other parts of Iceland or from the Färöe Islands, all of whom, of course, use the kind of boat to which they have been accustomed from time immemorial.

As a general rule, the Iceland fishing-boats are arranged in such a manner that they can be used both as sail-boats and row-boats, as occasion demands. The form of the boat is also adapted to the part of the sea where it is to be used, to the landing-place, &c. On the south coast of Iceland, and in some other places where the fisheries are carried on in the open sea and where there is rarely more than one landing-place, the boats are mostly row-boats. In the Faxe Bay the boats were formerly chiefly used as row-boats; but at present they seem to be in a transition stage toward sail-boats, with heavy ballast, because the boats are somewhat narrow, for which reason they can also, if necessary, be used as row-boats.

In most places in Iceland it will be necessary to have a boat which is adapted both to sailing and to rowing, as much as is possible, and which is suited to the sea and the landing-places where it is to be used. A boat which is arranged either exclusively for sailing or exclusively for rowing, even if absolutely perfect in either respect, will not prove so useful to the fishermen as a boat which combines both qualities. Wherever sails are introduced, care should be taken to adapt them to both stormy and calm weather. In Iceland there are no harbors for boats, and they must in nearly all cases be drawn ashore. On the south coast of Iceland only a mainsail is used, as a general rule. In the Faxe Bay a jib is also used, with two masts with staysails. In the western part of Iceland only a mainsail was used some years ago; but recently many fishermen have begun to use jibs. It is safe to assume that about two-thirds of all the Iceland fishing-boats have jibs. Objections made against the shape and rig of the Iceland vessels should be received with caution; and the criticism of Mr. A. seems unjustified.

5. On the south coast hand-lines from row-boats are almost exclu-

sively used during the fishing season, as long as there are any large codfish near the coast. If the cod are lean and if there are many haddock on the banks, as well as later in the season (especially after the spawning is over), long-lines are used. In the southern part of the Faxe Bay nets are used to catch the incoming cod; in March and April hand-lines are used as soon as the cod will bite, or as soon as haddock make their appearance. Long-lines are also used as soon as the codfish become inferior in quality. In the Westland no nets are used, and as a reason for this it is stated that when the cod approach the coast there are sharks among them, which are apt to injure the nets. Hand-lines without bait are used wherever there is a current, and long-lines with bait wherever there are fish to which this method of fishing is adapted. In the eastern fiords long-lines are generally used during the summer fisheries.

Making a rough calculation, it may be said that more than one-third, in fact nearly one-half, of all the fish caught are caught with hand-lines, and the remainder with nets or long-lines. The results of the net fisheries vary greatly. If properly cured, most of the fish caught with hand-lines will make the best klip-fish. The net fisheries yield the heaviest fish, but many of these make only a second or third-rate article, because the fish remain too long in the nets. The fish caught with long-lines are generally lean or small, and make only an inferior kind of klip-fish. In many places in Iceland hand-lines are preferred to the expensive nets. On rocky or stony bottom long-lines or nets could not be used at all. For catching the genuine large sea codfish, the long-line is rarely suited; while it is used a great deal for catching fish which have spawned, small codfish, and haddock.

6. Bait is substantially as Mr. A. has stated. Where lump-fish are caught, the roe of the female is very commonly used as bait, as well as the roe of other fish. In the entire southern portion of the Faxe Bay and in many other places a great many lump-fish are caught from April 1 to the end of June. To each fishing-boat belong at least from 3 to 5 nets, which during that period are set every day, not only to procure an article of food, but particularly because the roe, the sucking-disk, and the head make excellent bait.

7. It is true that crabs are found in the stomach of the codfish, but it must be said that the food of the cod is the same in Iceland as in other places, and that it is of so varied a character that it is difficult to enumerate it briefly. One of its favorite articles of food, when near the shore, is the sand-eel (*Ammodytes tobianus*) and different kinds of herring. The enormous number of sand-eels found near the coast of Iceland is the principal cause why the codfish and the haddock stay there not only during the spawning season but much longer.

8. The fishermen from the Färöe Islands do most of their fishing during the pleasant season of the year in the eastern fiords for small cod and haddock; and to call them the "best boat-fishermen at Iceland" is unjust to the Icelanders.

XXIV.—THE FRESHWATER FISHERIES OF ICELAND.*

[A report to the Assembly of Iceland.]

After making due preparation I reached Silfrastadir, Iceland, on July 19, 1884, and on the following day stopped at Lake Ljosavatn. At Akreyri I had been told that this lake was very deep, and partly for this reason and partly with the view to become acquainted with an Iceland lake as soon as possible, a man and boat were engaged to aid me in inspecting it. On the man taking me to the place where he thought the lake was deepest, I measured 6 fathoms; then 11, 13, 14, and 12. I had now passed the place which was supposed to be deepest, and as the boat was really not safe, I stopped measuring. Afterwards I was told that in some places this lake is 17 fathoms deep. The temperature of the water near the surface was $9\frac{1}{4}°$, and at the depth of 8 fathoms 8° Celsius. There are comparatively few fish in this lake, and they are small and not very fat, although I have been informed that some weighed as much as 8 pounds. The fish which I had occasion to examine weighed from one-quarter to three-quarters pound, and appeared in good condition. Most of them seemed to be trout, and but few were mountain-trout. The food of the fish consisted of larves of flies and gnats, and a few small snails.

Just here I must say, regarding the Iceland freshwater fish, that from time immemorial there has been a great confusion of names, both among the fishermen and the writers on this subject. I have not yet been able to finish examining the material I gathered; but I can state that the principal kinds of fish in the fresh waters of Iceland are salmon, trout, mountain-trout, eels, and sticklebacks. I must add, however, that there are different varieties both of the trout and the mountain-trout. The Iceland term *silungur* must be considered as a name borne in common by the various species of trout and mountain-trout, although in some places it means simply the trout, that variety which I would call the "gray trout." The word *sjoreidur* was used both for the trout and the mountain-trout which come up from the sea to spawn in fresh water. By the term *laksebroder* the Icelanders mean the fish which in Denmark is called white trout or salmon trout; *blekja* and *birting* are different

* "*Islands Færskvandsfiskerier.*" From *Fiskeritidende*, Nos. 25 and 26, Copenhagen, June 23 and 30, 1885. Translated from the Danish by HERMAN JACOBSON.

names for the mountain-trout, and *sjobirting* is the name of the trout which goes into fresh waters from the sea. There are a number of other local names used for these fish.

On July 20 I visited the Falls of the Goda and several points along the Skjalfanda River. A salmon-ladder might easily be constructed on the western side of the little fall, near the grotto, and possibly one might be constructed also near the great fall. The little fall is about 18 or 20 feet high, and the great fall about 42 feet. I took these measurements with a sounding-line, and as near the main current as possible.

The Skjalfanda River does not contain much animal life, and probably there is none at all in that portion which is near the falls. Nor was there any trace of vegetation. Above the Goda Falls the river has several tributaries containing trout and mountain-trout, which also go into the Skjalfanda. In its lower course there are said to be some salmon and trout; but there is no prospect that the fisheries in this river will ever be of any importance, and its whole character shows that it has never been rich in fish.

The Reykiadalsá River, with its tributaries, which flows into the Laxá River, and through the Vestmannsvatn and some other lakes, has an entirely different character. The nature of this valley and its animal and vegetable life show different and much more favorable conditions for the life of fish than the Skjalfanda and the valley through which it flows. In the Reykia valley the salmon are said to ascend very high, and there are many trout and mountain-trout. The salmon fisheries, however, have declined greatly. The spawning season of the salmon is supposed to be in October.

Making Mula my headquarters I made several excursions in the Laxá valley on July 21 and 22. Near Bruarfos there are falls, none of them, however, would hinder the ascent of salmon if the narrow passage on the west side of the largest island was widened somewhat, which could easily be done by blasting on both sides of the narrow passage. It is true that the falls are very long, but as there are resting-places here and there it may well be compared with a large natural staircase, and the fish could doubtless easily ascend it, provided that above the falls they could find natural conditions favorable to propagation and to the existence of young fry. I have not been able to obtain much information as to whether salmon have ever been caught above the falls, but it was thought that no suitable spawning places were there. In this respect I examined its course near Tverá, and also in the neighborhood of the Myvatn Lake, and several places would, in my opinion, be suitable for the spawning of salmon. But I must add that the conditions may be very different during the spawning season from what they were in July when I visited these places; possibly the water of the Laxá is in many places too warm, owing to its tributaries coming from the warm springs in the valley, and also on account of the numerous trout and mountain-trout which devour many salmon eggs.

Below Bruarfos the Kalvlækja flows into the Laxá, close to the old ford. Here there are extensive spawning places of salmon, as there are numerous banks formed by broken pieces of lava. As bridges have recently been built there is no necessity for using the ford during the spawning season (about from September 15 to November 15), and there is consequently no occasion to disturb the salmon during the spawning process. It would be better if the ford was used only from May till the middle of September.

On the right bank of the Laxá I visited the springs of a stream which flows into the Laxá, and which is said to contain numerous young fish. Here I had for the first time an opportunity to make some observations relative to the importance of the lava which forms the bed of many Iceland streams. It has already been stated in Eggert Olafson's and Bjarni Paulsen's valuable reports on Iceland that the salmon like those streams whose beds are composed of lava, because it abounds in hiding-places. Everywhere in Iceland the truth of this statement is borne out by the facts; but possibly the porous mass of the lava-bottom, together with the rapid current, is apt to form suitable hiding-places for the small animals which form the food of the young fish, while at the same time streams with water which is not too cold will form an attraction, when during winter there are cold snow-water and ice in the open river.

The vegetation in the Laxá is found to be very rich, showing many confervæ and plants of a higher order. In many places fishing becomes exceedingly difficult, because the hook or the artificial fish becomes entangled among the plants, where there are many places in which snails of various kinds, small mussels, and crustaceans can gather. I have often heard the opinion expressed that the hot springs tend to make the fish fat. This result is, of course, obtained only in a roundabout way. It is the animal life produced by the hot-spring water which furnishes rich food for the fish that makes it possible for them to become fat.

On the whole it must be said that there are spawning places at the mouth of most of the tributaries of the Laxá below Bruarfos. These tributaries are said to have much warmer water in winter than the river itself, as they come from springs in clefts between the lava underneath the meadows. The temperature of these springs is the same all the year round. I found it to be 4° Celsius. For this reason the brooks are always open in winter, and their comparatively warm water goes into the spawning places. Near the springs of one of these brooks, or at any rate somewhere along its course, fish could easily be hatched in sheltered places. To be on the safe side, however, a place should be selected at some distance from the springs, so that the water may contain sufficient air; although it is possible that these streams contain enough air, as many of them are probably nothing else but water from the Laxá, which, through the numberless fissures and clefts in the lava, flows in and out of the river. The water must be considered entirely pure. In passing

through the lava it has been filtered, and there is scarcely any mud, at any rate not in the winter.

The Laxá evidently has all the most favorable conditions for a good spawning place for salmon, and near its mouth are some falls, which do not in the least hinder the ascent of the salmon, but where they like to sport about. The salmon likes foaming waterfalls which seem to have a special attraction for it; this has at least been observed in many salmon waters. The stream of lava in ancient times formed a sort of dam across the river, and over this dam the water rushes with considerable force, forming the Laxamyri Falls. On July 23 I examined this place, accompanied by the thrifty owner, Sigurdjon Johannesson. The falls have five distinct divisions. The eastern part consists of two falls, separated by a large island. The salmon do not ascend the eastern branch, but are found in great number in the western branch. The ascent is easiest in the fourth fall, which consists of five or six natural steps. Near the top of this fall, in the western part, and extending as far as the middle of the stream, there is an apparatus for catching salmon. It consists of fences with perpendicular boards, whose land-arm is supported by five boxes formed of beams and filled with stones, while the outer or free arm has only three such supports. The two lower boxes are close by the side of each other, and to them the salmon-box is attached. This box is constructed of boards and has a triangular shape, and is furnished with an opening through which the salmon leap into the box. The ascent of the salmon is governed by the wind; if the wind is north the salmon go to the eastern, and when it is south to the western branch of the stream. The salmon therefore keep under the wind.

Some salmon are caught by means of sharp iron hooks attached to poles; these hooks are struck into the fish while it is ascending, the fisherman passing the hook through the water at random until he strikes a fish. By this method of fishing many salmon are severely wounded, and even if they are caught they lose their value somewhat as a marketable article. Occasionally salmon are caught also with nets in the deep holes below the falls after the fishermen have spied them from the rocks.

During the last few years the ascent of the salmon has begun late in the season, about June 14, and come to an end in the middle of August. Formerly the salmon began to ascend about May 25. If the salmon ascend early in the season, the fisheries close early. The ascent is easiest for the salmon during high water; that is, at the times of the new moon and the full moon. The difference of depth between the tides is 2 or 3 feet.

The annual income from the Laxamyri salmon-fisheries varies between 2,000 and 10,000 crowns [$536 and $2,680]. The fisheries vary a great deal in different years; thus, when I visited Laxamyri only about

4 barrels of salmon had been caught, and there was no prospect that many more would be caught during that season.

From Laxamyri I paid a visit to Benedikt Sveinson, member of the Assembly. Accompanied by him I visited the Reyder River and its mouth, as well as the place where Mr. Sveinson intends to start a hatchery at the mouth of a side branch of the river, which he intends to have dug. In olden times salmon are said to have gone up the Reyder River. Since I have learned more regarding those streams in Iceland which are adapted to the raising of salmon, I would not, at least for the present, recommend that any attempt be made to stock the Reyder River with young salmon. A hatching apparatus, however, might easily be constructed, from which other waters might be supplied with salmon or trout.

Sigurdjon Johannesson accompanied me when I left his hospitable and instructive farm, where I would gladly have remained several days. He went with me as far as the Myrarkvisl, a stream which, above Laxamyri, on the right bank of the Laxá, flows into it. The Myrarkvisl is said in former times to have been a good salmon river, and even now some salmon occasionally enter it. It looks to me as if in course of time the Myrarkvisl had gradually become so blocked up by stones and sand that the fish do not venture to enter it, or are actually prevented from entering it. The middle bank might be cut through, and probably also a portion of the grass-covered island which is found there; and the earth and stones which are dug out might be used for closing up the northern and the southern channels.

It can be observed that many of the Iceland streams have gradually undergone changes of current and depth by inundations, ice, landslides, and other causes, which may have had an unfavorable influence on the salmon. This circumstance should also be taken into consideration in judging of a stream which formerly contained many salmon, while now scarcely any are found. But, on the other hand, a stream may, in course of time, become better adapted to salmon. Thus, the earthquake of 1872 produced better conditions for salmon, especially for their ascent, in one of the eastern falls near Laxamyri. Thus far but little attention has been paid in Iceland to the changes which streams undergo in the course of years. The time may come, however, when in Iceland, as in countries where the streams have been constantly watched, natural defects in the rivers will be remedied artificially, and when people will cease to go on reaping the harvest of the water without ever contributing anything toward its increase.

I followed the course of the Myrakvisl to its junction with the Helgá, which comes from the warm springs near Uxahver. The temperature of the Helgá at the point where it flows into the Myrakvisl was 18° Celsius, while the temperature of the Myrakvisl was 13°, and at the point where the waters met 15° while the temperature of the atmosphere was 11½°.

From the Helgá I crossed the Reykiakvisl and traveled across the moor to Bruarfos, whence I followed the course of the Laxá along its left bank as far as Tverá, every now and then paying visits to the river till near midnight. The numerous warm springs contributed their share to give to the river the appearance of steaming, although along this entire course it is broad and flows slowly.

The following day (July 26) I examined a portion of the Laxá above Tverá. The river here is generally low, and there are several islands covered with shrubs. A few trout, weighing 3 or 4 pounds, are caught along the river; and in the deeper places mountain-trout are taken. There was a great abundance of slimy algæ, confervæ, &c. In winter the river is filled with ice, and the water during that season is very high, coming clear up to the edge of the lava bank, filling every fissure and crevice. When the water falls again a number of fish are found in the space between the water and the edge. As there is considerable fall along the entire distance, and as consequently the bottom contains but little sand and gravel, it does not seem probable that the salmon will find many suitable spawning places, which, moreover, would be exposed to many dangers on account of the ice and the rising of the water.

It is also probable that the temperature of the water in winter, even if ice forms here and there, will be so high that hatching will occur sooner than it should. At the same time it should not be forgotten that the high temperature of the water, while accelerating the hatching process, will also promote the development of the numerous small animals which form the food of the young fish. To judge from the various specimens of larves, small crustaceans, and snails, the lower grades of animal life are well represented, although of course the variety is not so great as in streams flowing through fertile meadows. The land through which the Iceland streams flow is generally sterile, and this circumstance is sufficient to explain the fact that there is no great variety of species, and that the number of individuals is limited. Iceland forms no exception to the old rule: that it is not enough if there is a sufficient quantity of water; the water must contain enough animal and vegetable life, without which fish cannot exist.

The Myvatn Lake has, from time immemorial, had the reputation of being Iceland's principal trout-lake, and the farmers living on its shores have always been known as expert fishermen. I cannot say that Lake Myvatn, as regards fish and fisheries, came up to my expectations. I remained on its shores five days (from July 27 to August 1), and devoted all my time to an examination of the natural conditions of this lake. As to its natural character, it may be divided in two parts, which may be termed the southern and the northern, although it should be stated that as regards the fisheries the eastern portion is the most important. The varying depth of water seems to determine the fish-life in this lake. The northern, and to some extent also the western, part is

shallow and contains but few fish, while the southern and eastern part is deeper. In this southern part I found a depth of 3½ fathoms, and it was comparatively rich in fish. From these preliminary remarks a tolerably correct idea of the character of this lake is gained. I should state that the only kinds of fish which were observed were the trout, the mountain-trout, and a variety of the sticklebacks.

From all reports it appears that the Myvatn Lake was richer in fish in former times than it is now, but I am inclined to think that the persons who made these reports were mistaken. It is surprising to see how little the Icelanders themselves know about the natural conditions of places which they see every day; and many of these conditions are not rightly understood, simply from lack of sufficient knowledge. As a cause of the decrease in the number of fish it was mentioned that there were in the northern and western portions of the lake many small particles of clay, which were said to have become detached from the bottom through the influence of heat, and which made the water muddy and killed the fish by adhering to their gills. It is true that the water in many places was very muddy; but this was not caused by small particles of clay, but by the spores of a slimy sponge which was "blooming" at the time. The mountain-trout are said to have suffered particularly; and I was informed that during the warm summer of 1880 many fish died. I was told that under these circumstances the fish came near the shore. The fish seem to prefer the east side of the lake, and the natural cause is this, that in this portion numerous little streams flow into the lake from the lava, whose water is purer and cooler than that of the lake. In winter these streams are comparatively warm, at least compared with the water of the shallow lake; and it is, therefore, natural that the fish like to spawn here. Here also they are principally caught. The fisheries are carried on with large nets or pieces of nets which are spread before indentations in the shore and also farther out.

In examining the northwestern, northeastern, and northern portions of the lake I found it on an average only 2 feet deep. In the eastern portion, where most lava blocks are found, there are large holes in the bottom 6 or 8 feet deep. In the shallow places, where the oars continually touch the bottom, it is composed of a soft, dark mud having a bad odor, and covered with a lighter grayish-yellow layer formed by the excrements of various animals. Here and there are patches of milfoil (*Achillea millefolium*), water-plantain (*Alisma*), and a few other aquatic plants. These patches of vegetation hide a rich animal life, such as the larvæ of flies, small crustaceans, and in the upper layer of mud small mussels. Gulls, ducks, and their young find a rich supply of food among these aquatic plants. As a general rule the water is tolerably clear, but in spite of this I could not discover a single fish during my trips across the waters of this lake. It is probable that the shallow, clear water, the muddy bottom, and the numerous birds keep the fish away. I was told that most of the fish caught in this part of the lake

are trout, at which I was astonished, as the mountain-trout is much more inclined to seek the bottom, because it draws the food toward itself, while the trout snatches the food when swimming rapidly. The entire northern portion of the lake is important on account of the numberless ducks found here, so that the profit gained from the sale of eggs far exceeds that obtained from the fisheries.

Besides the cold streams which flow into Lake Myvatn from the lava fields, there are some streams whose temperature is always higher than that of the air. The warm dam near Vogar had a temperature of $19\frac{1}{2}°$ Celsius at 1 p. m. on July 28. At the same time the temperature of the water of the lake in the immediate vicinity of this dam was 15° Celsius, both at the surface and at the bottom, while the temperature of the atmosphere was also 15°. It is evident that such favorable conditions of temperature must exercise a considerable influence on the plant and animal life.

At the farm of Mr. Haldur, at Kálfastrand ,I had an excellent opportunity to examine thoroughly the character of the fish of Lake Myvatn. Mr. Haldur is one of the most expert and best-informed fishermen on Lake Myvatn, and his information seems to be reliable. Near Kálfastrand the mountain-trout spawn after September 20, and it is supposed that this early spawning season is caused by the numerous springs in this southern part of Lake Myvatn. At Geiteyarstrand the spawning season begins somewhat later. In December it comes to a close, but occasionally specimens of mountain-trout, ready to spawn, have been caught in the latter half of April. I examined some of the several organs of the fish which we caught. Neither spawn nor milt seemed sufficiently developed to warrant as early a commencement of the spawning season as the end of September. The eggs were not larger than grains of mustard, and Mr. Haldur informed me that they reached the size of peas.

On the southern shore of Lake Myvatn I heard people talk a good deal about a little fish which they called *krus*. After many vain endeavors I succeeded in obtaining a piece of this fish. It is nothing but a variety of mountain-trout, but it is remarkably dark, and its head and body appear to be heavier than those of the mountain-trout. It is said to live in the fissures, crevices, and holes of the lava, and it is supposed that many of the subterranean lakes in the interior of the island are connected with Lake Myvatn. It may be that the variety of the mountain-trout which the natives called *krus* is influenced by the stay in these subterranean waters, and that from this circumstance it derives its dark color. The opinion that there is some sort of connection between the various subterranean waters of Iceland is widely spread, and on Lake Myvatn I was shown a ring which had been lost in the lake, and was found in a trout caught in a little lake near Husavik.

The fisheries on Lake Myvatn are carried on with floating-nets and stationary nets. These are 10 or 12 fathoms long and 2 feet deep (four

or five meshes). But the meshes vary in size in the different nets. The nets having the largest meshes are employed in catching male trout, because they have a thicker body, while the females are slender. The floating-nets are always heavier; they are 20 fathoms long, and in the middle 8 feet deep. Occasionally, however, some are used which are 12 feet deep.

Lakes Arnavatn and Sandvatn offer nothing of special interest to the observer; the former contains trout and mountain trout, and the latter mountain-trout alone. While the pack-horses were sent to Lundabrekr I rode with my companion to the Kráká, a considerable stream, which had every appearance of being a trout stream, although at the present time no fisheries were carried on. At Baldersheimar a farmer informed me that in former times there had been fishing in this river; but now no one seemed to care for it. Quite accidentally a trout, weighing 9 pounds when cleaned, had been taken last year on a sandbank. In the streams and ponds surrounding the lake there are small mountain-trout. Fisheries are about to be begun on this river. I was still more convinced of the correctness of my views when south of Baldersheimar I caught a young trout of this year's fry.

The conditions in Lake Svartarvatn are a feeble imitation of those in Lake Myvatn. A depression in a lava bed has to some extent called this lake into existence, and the volume of its waters has been increased by streams flowing into it from the surrounding lava beds. The kinds of fish are the same as in Lake Myvatn, but they are smaller and not so good, probably because the lake is gradually being filled with sand, which kills all animal life. The depth of this lake is slight, not exceeding 6 feet in any place.

Einar Fridericksson deserves great credit for having endeavored to improve the quality of the fish in his waters by introducing a larger breed from Lake Myvatn. For this purpose he had in November, 1883, and January, 1884, eggs of mountain-trout impregnated in Lake Myvatn, and brought the impregnated eggs to Lake Svartárvatn, where they were placed in one of the springs surrounded by stones, so that he could easily inspect them. He brought the eggs from Lake Myvatn in January. The temperature of the air was only 16° Celsius at the time the journey was made; but the eggs were packed in moss and wrapped in hay. After fifty days they were hatched.

I examined the spawning places on the shores of the lake and on the edge of the lava beds where the subterranean water gushes forth. The temperature of the water was 3¾° Celsius; it never freezes in winter. For the purpose of spawning, the fish go deep into the holes and caverns under the lava beds; but owing to the drifting sand these spawning places are gradually losing much of their importance. Thus, some years ago sixty male trout were caught in a shallow place with a fish-spear in a single day. The sand will probably eventually fill the entire lake and leave only a few small streams flowing into the Svartá River.

After having passed the river Svartá, I again came to the Skjalfanda. There are some trout in this portion of its course, and the spawning trout ascend all of its tributaries. In the stream called Kalfborgara, east of Lundabrekr, trout weighing 10 pounds are occasionally found. The fisheries are carried on by constructing a dam across the mouth (first in August, and several times later in the season), so that the bed of the stream is laid dry and the fish can easily be caught. The Skjalfanda, from Lundabrekr and as far down as Storevellir, is also a good salmon stream, as there are large spawning places, especially along the eastern bank. Here the river has a comparatively quiet course, is shallow, and, moreover, many tributaries supply it with good water. There is, therefore, a possibility that the salmon will feel at home here, if they can succeed in crossing the Goda Falls.

XXV.—STATISTICS OF NORWEGIAN FISHERIES IN 1880.*

By BOYE STROM.

TABLE I.—*Number of fishermen engaged in the cod, fat-herring, and mackerel fisheries in* 1880.

Districts.	Cod fisheries.	Fat-herring fisheries.	Mackerel fisheries.
Smaalenene	....	....	193
Akershus	....	....	102
Buskerud	....	....	....
Jarlsberg and Laurvig	....	....	852
Bratsberg	....	....	30
Nedenæs	....	....	266
Lister and Mandal	....	....	1,149
Stavanger	2,350	295	1,080
South Bergenhus	3,937	1,710	47
North Bergenhus	1,944	3,182	....
Romsdal	15,418	5,912	....
South Trondhjem	2,561	5,686	....
North Trondhjem	1,347	1,480	....
Nordland	33,387	13,475	....
Tromsöe	1,930	3,160	....
Finmark	17,567	230	....
Total	80,441	35,130	3,719

TABLE II.—*Result of the entire coast fisheries in* 1880.

Districts.	Cod fisheries.	Fat-herring fisheries.	Sprat and other small-herring fisheries.	Spring-herring fisheries.	Mackerel fisheries.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Smaalenene	....	....	6,743	....	8,174
Akershus	....	....	2,466	....	1,975
Buskerud	....	....	....	....	....
Jarlsberg and Laurvig	....	....	1,402	....	38,070
Bratsberg	....	....	....	....	1,447
Nedenæs	....	....	....	....	7,528
Lister and Mandal	....	....	7,526	....	70,494
Stavanger	35,168	3,835	18,823	178,059	58,057
South Bergenhus	39,206	12,901	82,356	12,677	813
North Bergenhus	18,878	70,943	10,195	1,372	....
Romsdal	629,897	128,992	3,521	38,592	....
South Trondhjem	75,072	161,498	214	....	....
North Trondhjem	11,632	36,577	1,608	....	....
Nordland	1,812,758	1,024,082	3,457	....	....
Tromsöe	17,067	90,198	32	....	....
Finmark	720,848	5,628	....	....	....
Total	3,360,526	1,534,654	138,343	230,700	186,558

* "*Tabeller vedkommende Norges Fiskerier i Aaret* 1880." Christiania, 1882. Translated from the Danish by HERMAN JACOBSON.

TABLE II.—*Result of the entire coast fisheries in* 1880—Continued.

Districts.	Summer fisheries for cod, ling, &c.	Salmon and sea-trout fisheries.	Lobster fisheries.	Oyster fisheries.	Total.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Smaalenene	....	1,452	5,146	....	21,515
Akershus	....	....	27	11	4,479
Buskerud	....	2,080	13	13	2,106
Jarlsberg and Laurvig	....	3,638	14,828	693	58,631
Bratsberg	....	482	3,457	....	5,386
Nedenæs	281	4,315	9,423	126	21,673
Lister and Mandal	3,979	24,380	18,484	5	124,868
Stavanger	1,846	16,849	38,332	....	350,969
South Bergenhus	19,267	6,756	12,468	55	186,499
North Bergenhus	6,697	4,818	4,040	214	117,157
Romsdal	10,263	11,269	2,237	54	824,825
South Trondhjem	9,916	18,972	....	155	265,827
North Trondhjem	16,348	4,274	....	129	70,568
Nordland	55,165	838	....	51	2,896,351
Tromsöe	53,044	910	....	....	161,251
Finmark	211,344	1,370	....	....	939,190
Total	388,150	102,403	108,455	1,506	6,051,295

TABLE III.—*Details of the cod fisheries in* 1880, *showing the number of fishermen and boats.*

Districts.	Total number of fishermen.	Fishermen fishing with—						
		Nets only.	Night-lines only.	Lines only.	Both nets and night-lines.	Both nets and lines.	Both night-lines and lines.	Nets, night-lines, and lines.
Stavanger	2,350	100	800	....	250	....	1,200	....
South Bergenhus	3,937	30	5	3,112	....	....	650	140
North Bergenhus	1,944	54	....	540	....	....	....	1,350
Romsdal	15,418	5,257	749	3,536	17	2,274	2,288	1,297
South Trondhjem	2,561	1,243	....	1,128	....	190	....	....
North Trondhjem	1,347	944	10	15	203	....	175	....
Nordland	33,387	16,733	11,563	2,829	1,599	....	663	....
Tromsöe	1,930	102	459	....	....	....	1,349	20
Finmark	17,567	1,346	3,279	5,646	1,025	54	5,933	284
Total	80,441	25,809	16,865	16,806	3,094	2,518	12,258	3,091

Districts.	Total number of boats.	Boats equipped with—						
		Nets only.	Night-lines only.	Lines only.	Both nets and night-lines.	Both nets and lines.	Both night-lines and lines.	Nets, night-lines, and lines.
Stavanger	620	25	200	....	95	....	300	....
South Bergenhus	1,425	6	1	1,103	....	....	272	43
North Bergenhus	374	9	....	140	....	....	....	225
Romsdal	2,540	699	155	561	3	350	533	239
South Trondhjem	505	216	....	263	....	26	....	....
North Trondhjem	329	224	5	7	47	....	46	....
Nordland	7,128	2,817	2,843	965	282	....	221	....
Tromsöe	669	17	133	....	....	....	515	4
Finmark	4,885	143	1,296	1,270	298	12	1,776	90
Total	18,475	4,156	4,633	4,309	725	388	3,663	601

TABLE IV.—*Quantity of codfish caught in* 1880.

Districts.	Total number of fish caught.	Caught with— Nets.	Night-lines.	Lines.	Liver.	Roe.	Number of fish-heads sold.
					Barrels.	*Barrels.*	
Stavanger	437, 800	28, 000	385, 000	25, 000	1, 572	706	....
South Bergenhus	591, 500	8, 000	72, 000	512, 000	760	792	212, 000
North Bergenhus	234, 000	51, 000	73, 000	110, 000	271	363	....
Romsdal	9, 560, 600	5, 569, 000	1, 152, 000	2, 839, 000	20, 392	13, 942	6, 455, 000
South Trondhjem	1, 160, 000	849, 000	....	311, 000	2, 686	2, 141	444, 000
North Trondhjem	215, 400	152, 000	46, 000	17, 000	439	233	....
Nordland	32, 098, 700	17, 454, 000	12, 831, 000	1, 814, 000	83, 158	42, 248	20, 982, 300
Tromsöe	348, 800	30, 000	292, 000	27, 000	807	144	....
Finmark	23, 626, 000	862, 000	9, 138, 000	13, 626, 000	56, 541	291	17, 485, 000
Total	68, 272, 800	25, 003, 000	23, 989, 000	19, 281, 000	166, 626	60, 860	45, 578, 300

TABLE V.—*Financial result of the winter and spring cod fisheries in* 1880, *and the average prices paid at the different fishing stations.*

Districts.	Value of the different products. Total value.	Fish without liver and roe.	Liver.	Roe.	Fish-heads sold.
Stavanger	$35, 168 03	$25, 410 69	$7, 541 25	$2, 216 09	....
South Bergenhus	39, 205 72	31, 323 84	2, 732 53	4, 581 19	$568 16
North Bergenhus	18, 877 65	15, 744 46	1, 444 25	1, 688 94	....
Romsdal	629, 897 55	415, 264 93	127, 637 14	68, 305 16	18, 690 32
South Trondhjem	75, 071 62	49, 982 00	12, 957 26	11, 216 07	916 29
North Trondhjem	11, 631 74	8, 638 44	1, 869 30	1, 124 00	....
Nordland	1, 812, 758 16	1, 209, 761 38	347, 865 61	222, 837 98	32, 293 19
Tromsöe	17, 067 31	13, 877 04	2, 565 30	624 97	....
Finmark	720, 848 18	533, 090 32	170, 006 34	1, 039 04	16, 712 48
Total	3, 360, 525 96	2, 303, 093 10	674, 618 98	313, 633 44	67, 180 44

Districts.	Average prices. Per 100 cod.	Per barrel of liver.	Per barrel of roe.	Per 100 fish-heads.	Calculated price per 100 fish with liver, roe, and heads.
Stavanger	$5 79	$4 80	$3 14	....	$8 04
South Bergenhus	5 28	3 59	5 79	$0 27	6 62
North Bergenhus	6 73	5 33	4 66	....	8 07
Romsdal	4 34	6 27	4 90	29	6 59
South Trondhjem	4 31	4 82	5 25	21	6 49
North Trondhjem	4 02	4 29	4 82	....	5 41
Nordland	3 78	4 18	5 28	16	5 65
Tromsöe	3 97	3 19	4 34	....	4 88
Finmark	2 25	3 00	3 56	11	3 06
Average	3 38	4 05	5 15	16	4 93

TABLE VI.—*Showing the number of fishermen and boats engaged in the fat-herring fisheries in 1880, and the prices paid.*

NUMBER OF FISHERMEN, BOATS, &c.

Districts.	Fishermen.	Men fishing with nets.	Men fishing with seines.	Net-boats.	Seines.
Stavanger	295	140	155	45	13
South Bergenhus	1,710	134	1,576	50	125
North Bergenhus	3,182	376	2,806	188	176
Romsdal	5,912	3,296	2,616	1,559	167
South Trondhjem	5,686	2,860	2,826	1,068	181
North Trondhjem	1,480	985	495	465	35
Nordland	13,475	6,800	6,675	2,160	501
Tromsöe	3,160	2,520	640	845	55
Finmark	230	150	80	63	5
Total	35,130	17,261	17,869	6,443	1,258

RESULT OF THE FISHERIES—QUANTITIES AND PRICES.

Districts.	Total quantity caught.	Caught with nets.	Caught with seines.	Total product.	Average price per barrel.
	Barrels.	*Barrels.*	*Barrels.*		
Stavanger	1,060	400	660	$3,835 08	$3 62
South Bergenhus	2,255	80	2,175	12,901 52	5 74
North Bergenhus	15,380	400	14,980	70,942 81	4 64
Romsdal	34,928	13,080	21,848	128,992 15	3 70
South Trondhjem	35,671	6,250	29,421	161,497 87	4 56
North Trondhjem	10,660	4,710	5,950	36,576 04	3 43
Nordland	372,250	108,800	263,450	1,024,081 60	2 76
Tromsöe	42,670	14,030	28,640	90,198 08	2 14
Finmark	3,000	1,150	1,850	5,628 00	1 88
Total	517,874	148,900	368,974	1,534,653 75	2 97

TABLE VII.—*Details of the mackerel fisheries in 1880.*

Districts.	Total number of fishermen.	Fishermen using drift-nets.	Boats having drift-nets.	Total number of fish caught.	Fish caught with drift-nets.	Total value of the fish caught.	Average price per 100 fish.
Smaalenene	193	193	59	202,500	202,500	$8,174 00	$4 02
Akershus	102	....	....	45,400	....	1,974 62	4 34
Jarlsberg and Laurvig	852	844	229	1,213,200	1,206,200	38,069 93	3 14
Bratsberg	30	30	10	54,000	54,000	1,447 20	2 68
Nedenæs	266	231	83	185,000	173,800	7,527 58	4 07
Lister and Mandal	1,149	1,104	311	2,171,094	2,121,194	70,494 45	3 24
Stavanger	1,080	1,060	269	1,847,400	1,846,400	58,057 10	3 14
South Bergenhus	47	15	5	25,290	23,290	813 38	3 22
Total	3,719	3,477	966	5,743,884	5,627,384	186,558 26	3 24

TABLE VIII.—*Details of the sprat and other small-herring fisheries in 1880.*

Districts.	Quantity of fish caught.	Total value of the fisheries.	Average price per barrel.
	Barrels.		
Smaalenene	8,760	$6,7[illegible]	$0 78
Akershus	6[illegible]4	2,465 [illegible]	3 83
Buskerud	.....	.....	.....
Jarlsberg and Laurvig	9[illegible]5	1,4[illegible]2 17	1 42
Bratsberg	.....	.....	.....
Nedenæs	.....	.....	.....
Lister and Mandal	13,[illegible]	7,5[illegible] 57	56
Stavanger	22,770	18,[illegible]	83
South Bergenhus	[illegible]	[illegible] 40	91
North Bergenhus	9,770	10,195 25	1 05
Romsdal	2,491	3,520 44	1 42
South Trondhjem	300	214 40	72
North Trondhjem	400	1,608 00	4 02
Nordland	2,700	3,457 20	1 29
Tromsöe	30	32 16	1 07
Total	152,898	138,343 45	91

TABLE IX.—*Details of the lobster fisheries in 1880.*

Districts.	Number of lobsters caught.	Product of the lobster fisheries.	Average price per 100 lobsters.
Smaalenene	56,000	$5,145 60	$9 19
Akershus	200	26 80	13 40
Buskerud	150	13 40	8 92
Jarlsberg and Laurvig	136,320	14,828 44	10 88
Bratsberg	43,000	3,457 20	8 04
Nedenæs	126,962	9,423 14	7 42
Lister and Mandal	189,934	18,484 22	9 73
Stavanger	416,201	38,332 30	9 22
South Bergenhus	163,927	12,467 90	7 61
North Bergenhus	45,676	4,039 56	8 84
Romsdal	27,246	2,236 72	8 23
Total	1,205,616	108,455 28	9 00

TABLE X.—*Details of the salmon and sea-trout fisheries in 1880.*

Districts.	Quantity of salmon and sea-trout caught.	Product of the salmon and sea-trout fisheries.	Average price per barrel.
	Barrels.		
Smaalenene	573	$1,451 48	$2 52
Akershus	.....	.....	.....
Buskerud	950	2,079 68	2 20
Jarlsberg and Laurvig	1,400	3,638 10	2 60
Bratsberg	200	482 40	2 41
Nedenæs	1,755	4,314 80	2 47
Lister and Mandal	10,056	24,380 22	2 44
Stavanger	8,446	16,849 42	1 98
South Bergenhus	4,475	6,755 74	1 50
North Bergenhus	2,650	4,818 37	1 82
Romsdal	9,370	11,269 13	1 21
South Trondhjem	12,162	18,971 98	1 55
North Trondhjem	2,247	4,273 52	1 90
Nordland	723	838 03	1 15
Tromsöe	820	910 39	1 10
Finmark	1,258	1,370 01	1 10
Total	57,085	102,403 27	1 80

TABLE XI.—*Details of the oyster fisheries in* 1880.

Districts.	Quantity of oysters.	Product of the oyster fisheries.	Average price per barrel.
	Barrels.		
Akershus	1	$10 72	$10 72
Buskerud	2	13 40	6 70
Jarlsberg and Laurvig	55	692 51	12 60
Nedenæs	14	125 96	9 00
Lister and Mandal	1	5 36	5 36
South Bergenhus	9	55 21	6 16
North Bergenhus	22	213 86	9 73
Romsdal	10	53 60	5 36
South Trondhjem	24	155 44	6 49
North Trondhjem	20	128 64	6 43
Nordland	6	51 45	8 58
Total	164	1,506 15	9 14

REPORT ON THE MACKEREL FISHERIES NEAR ULEHOLMENE, AT TJÖMÖE, IN THE DISTRICT OF JARLSBERG AND LAURVIG.

Number of fishermen	599
Number of boats	155
Number of fish caught	775,000
Total value of the fish at the fishing station	$24,924

Of the boats, 21 had a crew of 3 men each, and 134 of 4 men each, and each boat had 40 drift-nets. It is stated that one-tenth of the fish caught was consumed in the district, and the remainder sold at other places in Norway.

Besides the above-mentioned boats and crews, about 130 vessels, with a crew of 2 men each, were engaged in buying up fish. Of the mackerel caught in this district, the greater portion was sent to Christiania, and the remainder to Drammen, Tönsberg, Horten, Moss, and Frederikstad. The fisheries were carried on from 1 to 2 [Norwegian or Danish?] miles south of Lillefærder, and began May 23 and closed on July 21. The best fisheries lasted from June 12 to July 4, but throughout the entire fishing season they were subject to great changes, owing to calms or stormy weather. When the net fisheries come to a close, all the boats leave the Uleholmene and return to their homes. No further data can therefore be furnished as regards the fisheries carried on after the close of the fishing season proper, because only pilots while on service catch some fish for their own use. No one was fined for selling liquor or beer without a license, no life was lost, no one was injured, and no one was arrested.

THE HERRING FISHERIES AT THE LOFFODEN ISLANDS AND IN THE DISTRICT OF VESTERAALEN.

Under date of February 15, 1881, the superintendent made a report on these fisheries, from which the following extracts are given:

The appearance of the herring was first noticed at Sortland, where in the Sör Fiord, the inner arm of the Hogne Fiord, there were caught dur-

ing the latter half of July 150 barrels of small herring, which sold at 3 or 4 crowns [80 cents to $1.07] per barrel. Later in the season, during August, the herring made their appearance near the west and south coast of Langöe, near Hasselöe, and in the West Fiord, where near Flakstad 400 barrels of herring were caught. In the beginning of October the herring again made their appearance near Sortland, large numbers being noticed in the Siger Fiord and near Hindöe, where a large number of net and seine fishermen gathered. No very important catches, however, were made, partly because the herring here, as in other places, kept at a great depth for a long time, so that even the net fishermen but rarely reached them, partly because the weather grew very cold, and the fiord was covered with ice and snow to such a degree as to hinder the fisheries at the very time when the prospects of the seine fisheries grew brighter, and several seines had already been cast. The yield of the Sortland herring-fisheries was estimated at 3,000 barrels, principally "merchants'" and "medium" herring, which found ready buyers on the various merchant-vessels which had come to Sortland, at prices ranging from 17 to 20 crowns [$4.55 to $5.36] per barrel.

About the same time of the fisheries in the Siger Fiord, the herring also made their appearance near Öksnæs and in most of the fiords on the west coast of Langöe. Herring fisheries were carried on in the Rygge Fiord, the Barkestad Sound, the Langöe Sound, the Böröe Fiord, the Auen Fiord, the Skiel Fiord, as well as in the Sandset Bay, and the Godviks Bay, where the herring, although as a rule keeping in the depths, occasionally came near the shore, probably chased by cuttle-fish and cod. At the very beginning of the fisheries there was occasion to use the seines; and, on October 5, thirty-six hauls were made with seines near Öksnæs, many of them yielding a considerable number of fish. The majority of these fish, however, were lost, owing to the nature of the bottom. On November 9 the fisheries at Öksnæs came to a close, as the great mass of herring, though still near, continually kept at a great depth, and were but rarely caught even with nets; and as the rich fisheries which had begun in the Eids Fiord attracted the fishermen to that locality. The result of the Öksnæs fisheries is calculated at 10,000 barrels of salt herring. The fish were almost exclusively large merchants' herring, selling for from 17 to 21 crowns [$4.55 to $5.62] per barrel for net herring, and from 18 to 24 crowns [$4.82 to $6.43] for seine herring. The last remnants of seine herring fell in price to 5½ or 6 crowns [$1.47 to $1.60] per barrel, principally because there were but few buyers. Forty seines, 200 boats with nets, and about 1,000 men are said to have been engaged in these fisheries. The Eids Fiord, however, was again to become the principal place for these fisheries; and this time with a result which is certainly unique in the history of the Norwegian fisheries. Toward the middle of August large masses of herring were noticed in the Vesteraals Fiord, the arm of the sea between Langöe and

Hasselöe, whence the Eids Fiord runs farther inland. This news very soon brought together a very considerable number of net-using fishermen, not only from the neighborhood but also from more distant parts of Norway, who, for about 8 weeks, carried on net fisheries with varying, but on the whole encouraging, results in the outermost portion of the Eids Fiord, off Kvalsöe, and in the Vesteraals Fiord. The yield of these fisheries was all the more profitable, as the prices were kept up by the comparatively large number of merchant vessels which had come to the Eids Fiord, and rose in the same proportion as the hope that the herring would go farther up the fiord—thus enabling the fishermen to use seines—vanished day by day.

From 13 crowns [$3.48] per barrel the price at the end of August rose to 18, 20, and 22 crowns [$4.82, $5.36, and $5.89], and at these prices all the net-fish were sold in the outer part of the fiord. There are no absolutely reliable data as to the entire quantity of fish caught in nets, but the information which has thus far been obtained from experienced captains of merchant-vessels, who were on the spot from the beginning of the fisheries waiting for cargoes, gives reason to believe that the quantity of net-fish brought into the market from this period of the fisheries may be estimated at about 30,000 barrels, besides the considerable quantity of fish for home consumption, as scarcely any of the fishermen using nets, who reside in the district, sold any fish before they had amply supplied their own needs.

In September the great mass of herring was noticed on the landside of Kvalsöe, all through the deep waters of the fiord; and during that month, as well as during the first half of October, there were good and sometimes excellent net-fisheries exclusively in these waters. Some nights in October each boat caught from 10 to 15 barrels of herring, and as it is estimated that at this time there were in these waters about 1,000 net-boats, it is evident that the net-fisheries constituted an essential portion of the entire fisheries, although we have not even approximately correct estimates as to the quantity of fish caught. The number of fishermen was, as has been stated, so large that it was impossible for the insufficient number of superintendents, who were not not all appointed till the middle of October, to gather all the necessary information, especially as the fisheries were carried on in an entirely free manner and without any regard to much-needed regulations. In spite of the great quantity of fish, the net fishermen obtained high prices. Up to the week between the 24th and 30th of October, when the seine fisheries began, the price of a barrel of net herring was 24 crowns [$6.43]. In that week the price fell to 4½ crowns [$1.20]; but although it was as low as 4 crowns [$1.07], and perhaps less, tolerably good net-fisheries were carried on by a gradually decreasing number of fishermen until the middle of December.

Although, as has been stated, it is impossible to state even approx-

imately the result or the value of the net-fisheries, either as a whole or the average per boat, it can be stated with absolute certainty that they have yielded a very good, and in some cases even an exceedingly good, income to all persons engaged in them. As an instance of this it may be mentioned that a crew, consisting of three men, caught fish to the value of 12,000 crowns [$3,216], while individual fishermen repeatedly brought home fish to the value of from 400 to 800 crowns [$107.20 to $214.40] and more. The largest quantity of fish was certainly caught by fishermen from outside the district, but their experience and skill as well as their apparatus and boats were superior to those of the district fishermen, who unless they had imitated the example set them by the foreign fishermen would scarcely have caught as much as they did. During the entire period of their presence in the Eids Fiord the herring showed a tendency to stay in deep water. It has thus been observed that the herring, which generally when pursued by their enemies come to the surface, have during these fisheries endeavored to avoid the threatening dangers of every kind by going down to the bottom and remaining there. People think that this has been the cause why they remained in the fiord so long, instead of being, as formerly, chased out again by their pursuers, the cuttle-fish, after having stayed only a short while. The cuttle-fish when chasing herring is supposed to rise toward the surface, and by going down to the bottom and staying there quietly the herring would escape this enemy. Whatever may be the cause of this fact, it exercised a considerable influence on the net-fisheries until the arrival of the foreign fishermen. Carried on only by the inhabitants of the district, who, according to their long-established custom, sought the herring only near the surface, and whose net-rope was seldom more than 30 fathoms long, the fisheries would yield an unequal quantity of fish per boat; for the boats would fish close to each other, just according to their coming across a greater or smaller school of herring which had separated from the great mass of herring and had gone nearer the surface. It therefore happened frequently that one boat hauled in its net full of fish, while another boat not far from it hauled it in almost empty. But although people supposed that the great mass of herring remained near the bottom, no one thought of arranging their apparatus in such a manner as to reach the fish. The foreign net-fishermen took hold of the matter in an entirely different manner. Furnished with sufficiently long net-ropes, they searched for the herring toward the bottom, experimenting and letting the net down lower and lower, until at a depth of from 80 to 100 fathoms they found the great mass of herring and henceforth continued to make rich hauls. The district fishermen immediately began to improve their apparatus, and to imitate the example set them by the foreigners, and the result was that they too began to catch large numbers of fish.

While the net-fishermen for weeks had good and steady fishing, the

patience of the large number of seine fishermen was sorely tried. Already in August most of the seine fishermen had arrived, and were lying in different parts of the fiord, especially near Kvalsöe and Sildpold. At the end of August it is estimated that their number was about 100 sets; and their number increased from day to day, so that finally there were 200 in all. Some of them again left the Eids Fiord when the news came by telegraph that there were excellent fisheries near Salten, and some took part in the Öksnæs fisheries, but the majority returned to the Eids Fiord, still hoping that there would be good seine-fishing. On October 15 the herring at last made their appearance in considerable numbers farther out at sea, and partly came near the coast, so that some were caught; but the seine fisheries did not begin in good earnest till the week between October 24 and 30. The quantity caught during that period was estimated at 100,000 barrels; and later in the season the seines were in use every day, not one of them lying idle.

In the beginning the seine fisheries were carried on in a hitherto unknown manner. When about the middle of October large numbers of herring began to make their appearance out at sea, without however coming near the coast, a sort of despair took possession of the fishermen who had waited for the fish so long, and they attempted either to catch the fish out at sea or to drive them towards the coast. They formed themselves into sets, bound many seines together (it is stated as many as twenty), and cast them in the middle of the fiord; and, with several hundred fathoms of ropes, and by means of sail-boats, the entire long chain of seines, with the herring contained in them, was towed towards the shore. Often the contents were lost on the way, but sometimes the fishermen succeeded in securing a number of fish in this manner. This unusual and difficult method, however, soon became unnecessary, as shortly after the herring came to places where they could be caught in the usual manner.

We have no exact data as regards the total yield of the seine fisheries, but as far as they go they are presumed to be approximately correct. On November 6 the quantity of herring caught was estimated at 50,000 barrels, in addition to which about 125,000 barrels were supposed to be in the seines. On November 28 the quantity caught was estimated at 110,000 barrels, and the quantity still remaining in the seines at 100,000 barrels. The great fisheries (properly so called) thereupon came to a close; but although both on November 7 and on December 7 the storm broke some large seines, causing a loss each time of from twelve to twenty thousand barrels of fish, the above-mentioned quantity need not be estimated any lower, as there was some fishing all during November. The superintendents, therefore, estimate the total yield of the seine fisheries in round figures at 200,000 barrels of fresh fish, or 300,000 barrels of salted fish; if these figures are approximately

correct, the Eids Fiord fisheries with nets and seines must have yielded about 400,000 barrels of salted fish.

Although there were many merchant-vessels on the spot when the great seine-fisheries began, the price immediately fell to 10 crowns [$2.68] per barrel. Soon fish were sold at 9 or 10 crowns, and later the price varied from 8 to 5 crowns [$2.14 to $1.34], at which latter price all the fish were sold which had not been taken from the seines after the end of November. The quality of the fish was good throughout, as the fish caught were nearly exclusively merchants' herring and medium herring; but as many of them remained in the seines for a long time, partly because at times there were few buyers, and partly owing to the short days and the frequent high winds and snow-storms, the value of many of these fish was certainly diminished.

In spite of the rich yield of the seine fisheries, the income of the fishermen is stated to have been comparatively small. The share falling to each fisherman is stated by the superintendents to have been about 200 crowns [$53.60], to earn which sum most of the fishermen had to remain in the Eids Fiord about three months, under circumstances which caused the price of all the necessities of life to be very high. The manner of forming themselves into sets made the earnings of the fishermen about the same for each.

Already in the beginning of August there were about 100 merchant-vessels in different parts of the fiord, and this number increased from day to day, owing to the rich net-fisheries and the expectation of good seine-fisheries. From the time the seine-fisheries began, it is estimated that the number of vessels was from 200 to 300, among them many steamers. The short working-days, which were still further shortened by frequent storms, made it almost impossible to prepare properly the entire vast quantity of herring, and people therefore in many cases confined themselves to salting the herring without cleaning them. There was no lack of workingmen to prepare the herring. The majority of them came not only from the neighboring districts of Sortland, Hadsel, and Öksnæs, but also from the entire group of the Loffoden Islands; and the good wages which were paid for preparing herring, therefore, though in a different degree, benefited the entire district. With the net-fisheries, the preparing of the herring has certainly tended to improve the economical condition of the district very considerably. Previous to the Eids Fiord fisheries people were generally very poor, and without these fisheries there is reason to suppose that many of them would have had to suffer during the coming winter.

The steamers also frequently brought working-people of both sexes from distant parts of Norway. All in all from 8,000 to 10,000 strangers are supposed to have congregated on the shores of the Eids Fiord. No life was lost during these fisheries.

REPORT FROM THE TROMSÖE DISTRICT ON THE PARTICIPATION OF THE POPULATION IN THE FISHERIES IN THE ARCTIC OCEAN.

Under date of January 26, 1882, the governor of the district made a report, from which we take the following data:

In 1880 this district equipped in all 21 vessels, with a tonnage of 743 tons, and manned by 169 persons. One of these, with a tonnage of 35 tons and a crew of 10 men, belonged to Stavanger, while the others belonged to Tromsöe. Three of the vessels made two voyages each, the first to the banks to engage in shark fishing. Eleven of the expeditions were principally fitted out for cod fishing, and but few other fish were caught.

The total result of these fisheries was as follows:

	Crowns.	Dollars.
66 walruses, at 48 crowns [$12.86] apiece	3,168	849 02
3,380 seals, at 12 crowns [$3.21] apiece	40,560	10,870 08
490 whitefish, at 80 crowns [$21.44] apiece	39,200	10,505 60
17 bears, at 36 crowns [$9.64] apiece	612	164 02
379 reindeer, at 12 crowns [$3.21] apiece	4,548	1,218 86
990 pounds eider-down, 48 crowns [$12.86] per 36 pounds (*vog*)	1,320	353 76
240,200 fresh fish, at 8 crowns [$2.14] per 100	19,216	5,149 89
280 barrels cod livers, at 13 crowns [$3.48] per barrel	3,640	975 52
461 barrels shark livers, at 14 crowns [$3.75] per barrel	6,454	1,729 67
10 barrels whale fat, at 10 crowns [$2.68] per barrel	100	26 80
Total	118,818	31,843 22

REPORTS ON THE FISHERIES IN THE DISTRICT OF FINMARK, THE PARTICIPATION OF THE POPULATION IN THESE FISHERIES, THE FISHERIES IN THE ARCTIC OCEAN, AND THE RESULT OF THESE FISHERIES.

1. The Winter and Spring Cod Fisheries.

Under date of November 30, 1880, the governor of the district made the following report:

The winter fisheries (from new year's to the beginning of the caplin fisheries) have during the present year been very insignificant. In most of the districts they were a complete failure, and in none of them were the fisheries of any importance.

The following are the statistics of these fisheries:

	Number.
Fishermen	1,930
Fish caught	364,500
Barrels of liver	664
Barrels of roe	166

Total value of the fisheries, 44,698 crowns [$11,979.06]. The number of persons who lost their lives during the winter fisheries was 3.

The caplin were this year first noticed near Vardöe and Berlevaag

on March 1, and a few days later they showed themselves near Havningberg, Baadsfiord, Gamvik, and Mehavn. About the middle of the month they came near the coast along its entire extent from Vardöe to the district of Kjelvik, and also at Ingöe in the district of Maasöe. At the other stations of the Maasöe district the caplin were not noticed till the end of the month. Further west there were no caplin fisheries during this year. Near Kiberg the fish made their appearance during the last of April, while in Varanger Fiord, with the exception of some of the outer stations, where they already came in the beginning of April, and Vadsöe, where they were noticed during the first days of March, they did not make their appearance till the middle of May. At all the stations the caplin stayed till some time after the middle of May, when they left all the stations on the coast about the same time. At some stations in the South Varanger Fiord they remained, however, till the first of June. Large masses of fish first came near the coast at Berlevaag in the beginning of March, about the middle of the same month at Mehavn and Gamvik, and about the end of the month at Ingöe. In the beginning of April the schools of codfish came near the coast at Rolfsöe, Hjelmsöe, and Havningberg, and during the second half of April large masses of them came near the land along the entire coast from Maasöe to Kramvik. In Varanger Fiord the cod were noticed near Great Ekkeröe during the first of May, but at the other stations in this fiord not till a fortnight later; nor did they remain any longer than the end of the month. At that time the great mass of fish also disappeared from the other stations in East Finmark, while in West Finmark they had disappeared somewhat earlier.

The richest fisheries—and they were exceedingly rich—occurred during the last ten days in April and the first ten days in May. On April 20, only a little more than a million and a half had been caught, while by May 9 the number of fish caught amounted to 17,000,000. The following table will show the quantity of fish caught and the number of boats engaged in the fisheries at the more important fishing-stations:

Stations.	April 9.		April 16.		April 22.		April 29.		May 6.	
	1,000 fish.	Boats.	1,000 fish.	Boats.	1,000 fish.	Boats.	1,000 fish.	Boats.	1,000 fish.	Boats.
Ingöe	45	180	55	195	136	240	730	345	1,300	352
Hjelmsöe	60	150	80	200	150	210	700	300	1,500	280
Gjæsvær	30	125	65	170	400	290	1,000	370	1,600	373
Mehavn	74	84	278	151	610	200	1,560	327	2,360	300
Gamvik	90	78	140	136	260	164	710	185	1,050	180
Berlevaag	400	180	560	250	940	260	1,350	200	1,800	200
Sylto Fiord	7	32	77	64	160	79	270	98	800	116
Vardöe	35	106	48	184	182	264	1,500	315	1,900	348

The number of fishermen who lost their lives during these fisheries was fifty-seven. No change was noticed in the method of carrying on these fisheries. The sanitary condition of the fishermen was very good,

At Gjæsvær alone there was some sickness among the fishermen during the first days of May, but it did not assume the character of an epidemic, and as early as the middle of May the sanitary condition was reported as good.

The fishermen, fishing-boats, and merchant-vessels were counted on May 8, and on that day the number of fishermen was 15,447 (among them 861 from Sweden, Finland, and Russia). The number of boats was 4,320 (with 76 from Russia). One hundred and six persons on board merchant-vessels also carried on fisheries. For the sake of comparison we give the following figures from previous years:

Years.	Number of fishermen.	Number of boats.
1876	10,703	3,320
1877	10,537	3,226
1878	16,429	4,644
1879	17,325	4,902

As regards the apparatus employed the report states the following: On the day when the count was taken 329 men with 73 boats were exclusively engaged in net fisheries, 4,345 men with 1,349 boats in night-line fisheries, 5,265 men with 1,243 boats in deep-bait fisheries, while 5,508 men with 1,655 boats used both night-lines and deep-bait. One hundred and seven men with 29 boats also used nets. These net-fisheries were carried on principally at several places in the South Varanger Fiord. In the district of Hasvik, at Sværholt, and in Varanger Fiord proper, no deep-bait fisheries were going on. It also appears that the inhabitants of the district engaged in net fisheries only to a very limited extent, the apparatus which was principally used being the night-line. The fishermen who came from the district of Nordland, as well as those from the southern portion of the Tromsöe district, mostly carried on deep-bait fisheries.

The number of vessels engaged in these fisheries and their tonnage was as follows:

Years.	Vessels.	Tonnage.
1876	286	12,921
1877	257	12,436
1878	260	12,389
1879	317	14,922
1880	314	15,462

During the latter year the vessels were manned by 1,644 men.

Good order seems to have been preserved during these fisheries. The total number of fines imposed was only forty-five, six of which were for selling liquor without a license, and twenty-one for violations of the fishery law.

The price of the raw product varied between 6 and 11 crowns [from $1.60 to $2.94] per barrel. Exceptionally, especially during one week in the middle of May, the price fell to 5 and even to 4 crowns [$1.34 and $1.07], and at Gjæsvær, even as low as 3 crowns [80 cents], but only a small quantity of fish was sold at these low prices, which were caused by the circumstance that the merchant-vessels all had their full cargo. The price of liver varied between 10 and 12 crowns [$2.68 to $3.21] per barrel, except at Mehavn and Berlevaag, where the price ranged from 12½ to 14 crowns [$3.35 to $3.75], and at Sand Fiord, where it went as low as 9 crowns [$2.41]. For some days the same price was also paid at Kjelvik; and at Ingöe liver sold at 8 crowns [$2.14] per barrel.

The following were the results of the cod fisheries in the district of Finmark, in 1880:

	Number.
Fish caught	23,626,000
Barrels of liver	56,541
Barrels of roe	291

Total value, 2,689,732 crowns [$720,848.17].

The efficiency of the various apparatus employed will appear from the following figures:

	Number.
Caught with nets	862,000
Caught with lines	7,808,000
Caught with trawls	11,969,000

Besides these, 2,987,000 fish are stated to have been caught with lines and trawls, without specifying how many were caught with each of these apparatus. Two hundred and nineteen thousand fish are stated to have been used for home consumption.

The number of fish caught during previous years was as follows:

Years.	Number.
1875	19,750,000
1876	5,250,000
1877	17,750,000
1878	12,000,000
1879	19,330,000

As far as known, the cod fisheries have in no previous year yielded as large quantities of fish as in 1880.

Besides cod there were caught during the winter and spring fisheries, 257,000 haddock, 99,000 pounds of halibut, and flounders to the

value of 3,500 crowns [$938]. The number of fish-heads sold was 17,485,000, at prices ranging from 24 ore to 1 crown [from 6 to 26 cents, about] per 100.

The financial results of these fisheries during previous years were as follows:

Years.	Crowns.	Dollars.
1875	3, 340, 000	895, 120
1876	1, 072, 000	287, 296
1877	3, 675, 000	984, 900
1878	2, 069, 000	554, 492
1879	2, 666, 000	714, 488

As has already been stated, the number of fishermen engaged in these fisheries in 1880 was 15,447; the average earnings of every man, therefore, amounted to 175 crowns [$46.90].

Of the total quantity of fish caught the following quantities were prepared in different ways:

	Number.
Whole stock-fish	9, 592, 500
Split stock-fish	515, 000
Klip-fish	13, 299, 500

In West Finmark one barrel of liver generally held 525 livers, while in East Finmark the number was 580. The quantity of liver contained in the fish was, therefore, less during this year than during the previous year, as in 1879 475 livers went to a barrel in West Finmark and 340 in East Finmark. The fish did not weigh as heavy as in 1879, 120 codfish making only 120 pounds of whole stock fish and 180 pounds of klip-fish. At some of the fishing stations 120 codfish made only 105 pounds of whole stock-fish.

The quality of codliver oil prepared for medicinal use was 4,090 barrels.

2. Other Fisheries.

Under date of May 27, 1881, the governor of the district of Finmark made the following report:

A.—Summer and autumn fisheries for pollock, cod, &c.

Value of the fresh fish, 459,432 crowns [$123,127.77].

Split stock-fish, 517,428 pounds; valued at 57,482 crowns [$15,405.17].

Dried pollock, 805,500 pounds; valued at 35,410 crowns [$9,489.88].

Other fish; value, 92,230 crowns [$24,717.64].

Number of barrels of liver, 13,874; which was valued at 149,155 crowns [$39,973.54].

Total value, 793,709 crowns [$212,714].

The total number of men engaged in these fisheries was 9,655, of whom 5,119 were foreigners.

The average earnings of each man were 82 crowns [$21.97], against 104 crowns [$27.87] in 1872.

Eight men lost their lives during the fisheries.

B.—*Fat-herring fisheries.*

In 1880 these fisheries were carried on only in the Porsanger Fiord. The number of men engaged was 230, with 83 boats. Of these, 150 men with 63 boats used nets and 80 men with 20 boats used seines. The total quantity of herring caught was 3,000 barrels, of which 1,850 barrels were caught with seines. The average price paid was 7 crowns [$1.88] per barrel, the total income from these fisheries amounting to 21,000 crowns [$5,628]. The number of merchant-vessels engaged in these fisheries was 8, with a tonnage of 240 tons and a crew of 27 men.

C.—*Shark fisheries.*

Number of boats, 25; of fishermen, 96.

Number of vessels, 19; tonnage, 407 tons; crews numbering 97.

Number of barrels of liver obtained, 2,531; valued at 34,045 crowns [$9,124].

The average share of each boat-owner was 72 crowns [$19.30] and of each fisherman 55 crowns [$14.74] at Lebesby, 88 crowns [$23.58] at Hammerfest, and 156 crowns [$41.80] at Vadsöe and Vardöe.

At Vardöe and Hasvik these fisheries were carried on during the months of June, July, and August at a distance of from 1 to 2 miles [5 to 10 English miles] from the coast; and at Tanen during June and July at the same distance. Near Hammerfest and Alten these fisheries were engaged in on the banks off the coast, as also near Spitzbergen, from June till September. One man lost his life during these fisheries.

D.—*Walrus, seal, and other fisheries in the arctic regions.*

Number of vessels, 13, with tonnage of 416; number of fishermen, 125.

Total value, 84,796 crowns [$22,725.33].

Number of walruses caught, 256; of seals, 5,004; of bears, 38; of reindeer, 100. Quantity of eider-down obtained, 300 pounds.

One vessel from Vardöe carried on cod fisheries in the Arctic Ocean and caught 30,000 cod, the share of each fisherman being 294 crowns [$78.79].

E.—*Whale fisheries.*

Number of whales caught or driven ashore, 164, with a total value of 233,110 crowns [$62,473.48].

Total result of the Finmark fisheries in 1880 (*in round figures*).

	Amount.
Winter and spring fisheries	$721,188
Summer and autumn fisheries	212,792
Fat-herring fisheries	5,628
Shark fisheries	9,112
Polar-Sea fisheries	22,780
Whale fisheries	62,441
Total	1,033,941

Report on the herring fisheries near Iceland in 1880.

1. The governor of the district of Lister and Mandal, under date of May 23, 1881, reports as follows:

Two Mandal merchants sent to Iceland 2 sets of seines, with 32 fishermen, who caught 16,000 barrels of herring, with an average value of 8 crowns [$2.14] per barrel of fresh herring. The Mandal fishermen fished exclusively in the Seydis Fiord, and to aid them hired a number of Iceland fishermen. These Iceland fishermen got their board and 5 crowns [$1.34] per day. The Mandal merchants had the herring salted on the spot and brought them home to Mandal, with the exception of 1,200 barrels, which were sold in Iceland.

2. From the Stavanger district we have the following report:

From Stavanger there were in 1880 sent to Iceland 3 sets of seines, with 96 men, who caught 22,000 barrels of fresh herring, at an average value of 8 crowns [$2.14] per barrel. These fish were caught principally in the Eski Fiord and the Nord Fiord.

From Haugesund in 1880 there were sent to Iceland 12 sets of seines (67 seines in all), with 285 fishermen, who caught 27,657 barrels of fresh herring.

From Skudesnæs 22 men, with 1 set of seines, went to Iceland and caught 2,800 barrels of herring.

3. From the district of South Bergenhus we have the following report:

From Sveen 3 vessels, with 16 men and 1 set of seines, went to Iceland in 1880 and caught 1,950 barrels of fresh herring. The earnings of each man were 400 crowns [$107.20], and the net income of the company which had fitted out these vessels was 25,000 crowns [$6,700]. These fisheries were exclusively carried on in the Mjöe Fiord, on the east coast of Iceland.

From Stordöe there were sent to Iceland 2 vessels, with a capacity of 1,000 and 500 barrels, respectively, with 1 set of seines and a crew of 14 men. These vessels caught 1,800 barrels of herring, with a total value of 14,400 crowns [$3,859.20]. These fisheries were carried on during the latter part of July and during August, and principally in the Öya Fiord, on the north coast of Iceland. Later in the season two other vessels, with 1 set of seines, were dispatched to Iceland from Stordöe, but we have no information as to their success.

From Sund there was sent only 1 set of seines, consisting of 3 seines and 2 large and 3 small boats, and a crew of 20 persons, who caught 3,500 barrels of herring, valued at 28,000 crowns [$7,504], the share of each man being 320 crowns [$85.76].

4. From Bergen we have the following report by the committee of the Bergen Exchange:

As far as known three expeditions were dispatched to Iceland from Bergen in 1880, with 4 sets of seines in all. The total quantity of herring caught amounted to about 19,950 barrels.

5. From Aalesund we have the following report:

One set of seines, with 11 men, was dispatched to Iceland, and caught 2,812 barrels of herring, at an average value of 8 crowns [$2.14] per barrel. These fisheries were principally carried on in the Öya Fiord, on the north coast of Iceland.

XXVI.—CENTRAL ADMINISTRATION OF NORWEGIAN FISHERIES NEEDED.*

[A Circular from the Board of Directors of the Association for the Promotion of the Norwegian Fisheries.]

Our fisheries occupy a very prominent place among the industries of Norway. The annual value of the fishery products exported from Norway from 1866 to 1883 was as follows:

Year.	Average per annum.	Year.	Average per annum.
1866–'70	$8, 924, 400	1881	$13, 453, 600
1871–'75	11, 202, 400	1882	12, 622, 800
1876–'80	11, 550, 800	1883	11, 443, 600

These figures, however, do not represent the total value of the fisheries, as a large quantity of fish is of course consumed at home, nor do they include the income from the seal and whale fisheries.

For the sake of comparison we give below the value of other products exported from Norway during the same period:

Average per annum.

Years.	Forest and wood industry.	Other articles.	Foreign goods re-exported.
1866–'70	$8, 308, 000	$2, 170, 800	$214, 400
1871–'75	12, 033, 200	4, 529, 200	696, 800
1876–'80	10, 398, 400	5, 218, 800	750, 400
1881	12, 033, 200	6, 432, 000	482, 400
1882	12, 301, 200	7, 209, 200	830, 800
1883	11, 788, 400	7, 102, 000	830, 800

On an average, therefore, the value of the fishery products exported from Norway was 41.8 per cent of the total exports.

According to the census of 1876 the number of persons engaged in the fisheries was 52,587, and this number has now considerably increased. From the official reports it appears that the number of fishermen in 1882 was 78,589, distributed as follows: 61,357 in the cod fisheries, 4,448 in the caplin fisheries, 2,766 in the mackerel fisheries, and 10,000 in the spring-herring fisheries. If we add to these the large

* "*Om en Centralstyrelse for vore Fiskerier.*" From the *Norsk Fiskeritidende*, vol. iv, No. 1, Bergen, January, 1885. Translated from the Danish by HERMAN JACOBSON.

number of men who during the winter carry on haddock fisheries near their homes, and the number of persons engaged in the seal and whale fisheries, in the Arctic Ocean fisheries, and in the fat-herring fisheries, we may give 100,000 as the number of men who gain their support either exclusively or in part from the fisheries.

For the sake of comparison we give the number of fishermen in some other countries, as follows: France, 82,700; Canada, 47,200; Scotland, 48,100; Netherlands, 11,250.

In consideration of the great and varied interests connected with this industry, the desire has often been expressed to have these interests represented in the central Government by a competent and responsible person.

In the report of the Norwegian Government of December 23, 1881, approved by royal decree of January 7, 1882, relative to the appointment of a director of the salt-water fisheries, a review is given of all that has been done in this matter since 1859, when the subject was first broached. The matter was discussed during the Fishery Exposition at Bergen in 1865. At this meeting it was not deemed advisable to pass any resolution in regard to this matter, as it was thought that the expressions of opinion, which especially showed the desirability of having a central administration of fisheries and of forming a society for promoting the fisheries, would be sufficient to direct the attention of the Government to the subject. The direct result of the different propositions was, however, very different from the one aimed at, namely, to have some man in authority who would watch over the interests of the fisheries, and act the part of an adviser to the Government. All that was obtained was an annual appropriation for practical and scientific investigations; which of course are of importance to the fisheries but which constitute only a part of the duties of a commission of fisheries, and this a very insignificant one, if, as is the case with us, the appropriation is so small as to allow only special investigations on a very limited scale.

In 1879 the Association for the Promotion of the Norwegian Fisheries was formed; and thus a way was found for satisfying demands, which it was thought could best be satisfied by a voluntary association. Since 1881 this association has received from the Government the annual sum of $3,216. Although various questions relating to the administration of the fisheries have been referred to the association for decision, and although it has made several propositions relating to the same subject, the whole matter of a central administration of fisheries has been mentioned only incidentally. The principal aim of the association is, and will be as long as its present organization lasts, to develop the fisheries as a branch of our industries; and in this respect the association has, during the few years of its existence, done some good work.

The question of a central administration of our fisheries remains, therefore, in the same condition as in 1859, only with this difference, that

during the twenty-five years which have elapsed the fisheries have developed to such a degree as to make the desire for such an administration stronger and more general, and to define more clearly the duties which should be assigned to it. The fisnery association of the district of Nordland in its memorial dated September 29, 1881, states that "the importance and necessity of such an office are so self-evident that no proof is needed," and we fully agree with our northern colleagues.

During the last twenty years the fisheries, the principal industry of our country, have given rise to special administrative measures; superintendents' offices have been established for the great fisheries; roads and telegraph lines have been constructed for the special benefit of the fisheries; soundings have been taken on the banks of the sea, and charts of our seas have been published; a special fund has been created for constructing harbors; another fund has been started for the benefit of sick or disabled fishermen, which disburses annually about $13,400; special officers have been appointed to superintend the freshwater fisheries; the fishery statistics have been systematized; and on the whole a good deal has been done to promote our fisheries. For all these purposes, and for the practical and scientific investigations referred to, as well as for the Association for the Promotion of the Norwegian Fisheries from $160,000 to $180,000 are spent every year; and there is no likelihood that these efforts will be discontinued, but, on the contrary, there is every prospect of their being increased.

Besides those persons who have charge of the different branches of activity referred to above, there are a number of other authorities, functionaries, corporations, &c., who are either in direct relation with the fisheries, or who publish reports, memorials, and propositions relating to them. These are district governors, mayors, consuls, trade associations, financial committees, &c. We therefore already possess many of the elements needed in an administration of fisheries. With due regard to individual effort, it must be said that the demands of the fisheries are at present to a great extent dependent on accidental knowledge of the fisheries, or accidental interest taken in them by this or that person; and that invariably either the one or the other is not found to exist to such a degree as the true interests of the fisheries require. There is consequently a more urgent need than ever of having our fisheries represented in the central government by an independent (*i. e.*, of other offices), competent, and responsible authority, whose activity should not be confined to mere office work and the compilation of statistics and information, but which should take the initiative in different enterprises, and should systematize this work. As far as we know, there is no difference of opinion with regard to this matter; and if so far nothing has been done, the reason must be sought partly in the fear of the expense connected with it, and in the uncertainty as to the best manner of practically carrying out the idea; partly, also, in the circumstance that no one interested in the fisheries has been found to

speak for this. The long time which has elapsed during which no serious attempt has been made to settle this question is in itself a proof of the necessity for having the fisheries specially represented in the central administration. It may be useful in this connection to give a brief review of what other countries have done in this respect.

SWEDEN.—At present the fisheries are in charge of the managing committee of the Royal Academy of Agriculture, whose chairman, who is also always the director of the academy, is appointed by the King. This committee appoints the following officers, who are responsible to it: One superintendent of the freshwater and Baltic fisheries, with two assistants; and one professor of fish-culture.

Several of the provincial agricultural associations have a superintendent of fisheries, who is paid in part by the provincial government and in part by the association, and who has to report to both. Halland, Malmöhus, and Christianstad have a superintendent in common, while Bohus, Wärmeland, Södermanland, Gefleborg, and Linköping have one each. In those districts which have special fishery laws, the districts appoint district superintendents, who report to the provincial superintendent. In 1883 the Association for Promoting the Bohuslän Fisheries was formed, whose object is the same as that of the Norwegian association.

A royal commission, appointed to consider the propriety of changing the fishery laws, has in its memorial, dated March 3, 1883, proposed the creation of a commission of fisheries, to consist of one director, one secretary, four superintendents of fisheries, each having a separate district, and a number of ichthyologists, employed temporarily for special purposes. The director is to be appointed by the King, and the other officers by the Secretary of the Interior.

DENMARK.—The fisheries are under the Department of the Interior. In Lym Fiord there is a superintendent of fisheries, with one assistant and four rowers. In the Cattegat a gunboat is stationed to watch over the fishing interests, and on the west coast of Jutland there is an armed schooner for the same purpose. The department pays a gentleman to act as adviser in all matters pertaining to the fisheries, but, as that gentleman holds another office, the fisheries are to him only a matter of secondary interest, and his pay is only $268 per annum. In 1884 there was formed an association to promote the fisheries in Denmark and the Danish Colonies (especially the two islands, Iceland and Greenland).

There is a project on foot to change the present arrangement in connection with a proposed revision of the fishery law. It is proposed to have two inspectors of fisheries, one for the Danish Islands and the south of Jutland, to be stationed at some place on the Great Belt; and one for the north of Jutland, to be stationed at some place on Lym Fiord. Each of these inspectors is to have two assistants and a number of rowers. In order that the provisions of the law may be properly

carried out, each fiord is to have a superintendent of fisheries, who is to be appointed and paid by the district authorities.

GERMANY.—The police authorities see to it that the fishery laws are properly observed. The Government, however, is at liberty to appoint special officers for this purpose. Fishery associations, towns, and many owners of large fisheries appoint and pay officers, who are subordinate to the authorities appointed by the Government. Several associations are active in promoting the fisheries.

THE NETHERLANDS.—The superintendence of the salt-water fisheries is in the hands of a board (*het Collegie voor de Zeevischerijen*) composed of fifteen members appointed by the King, one-third of whom retire from office every year. There is a provision of the fishery law, according to which no member of this board can have a pecuniary interest in the fisheries. The board selects five of its members, as a managing board, to attend to the current business. Each province is represented in the board, which meets only once a year, while the managing board meets every third month. Its business consists principally in collecting statistics relative to the fisheries, in furnishing information on matters pertaining to the fisheries, and in promoting the fishing interests in every possible way. Every year it publishes a report containing detailed statistics of the Dutch fisheries, a review of the fisheries in other countries, and different articles on the condition of the Dutch fisheries and on various means of promoting them. The report is edited by the secretary of the board, at present a professor of law at the University of Leyden, the different members of the board furnishing him with the necessary material. The secretary receives a salary of $241.20 per annum, while the other members of the board are merely paid their traveling expenses for all journeys undertaken in the interests of the fisheries. Under this board there are twelve *keurmeesters* or "branders," who now, since the barrels are no longer branded, have to classify the herring brought in by the fishing-boats before they are sold at public auction.

For superintending the fisheries there is one steamer and six sailing-vessels on the river Schelde, and a steamer to watch over the oyster fisheries in the Zuyder Zee. This last-mentioned steamer is also to see to it that no nets of the kind called "*knilnetten*" are used from May 15 to July 15, during the period when their use is forbidden by law. All the officials connected with the superintendence of the fisheries are under the board.

For the practical and scientific investigations which, so far, have principally been directed to the raising of oysters, there is a traveling zoological station, maintained by the *Nederlandsche Dierkundige Vereeniging* [Netherlands Zoological Society], which receives some aid from the Government.

BELGIUM.—The fisheries belong under a bureau in the Ministry of Public Works—the Bureau of Maritime Affairs. In each of the 4 sea

districts there is a marine commissioner, who has to report to the chief of the bureau referred to, and whose duty it is to see to it that the fishery laws are properly enforced. To these commissioners fishermen can appeal in all matters pertaining to the fisheries.

FRANCE.—In the Ministry of Marine there is a special bureau for the salt-water fisheries (the Bureau of Fisheries), which is under the commissary-general, who has charge of recruiting the hospital service, as well as of the pay and clothing of the navy. The functionaries in the districts (prefects of marine) and in the subdistricts, who are under the commissary-general, have also the fisheries in charge. In districts where there are extensive fisheries there are special inspectors of fisheries, of whom at present there are 18, who have to see to it that all the fishery regulations are properly observed. Among the persons connected with the administration of the fisheries we must include the so-called superintendents of fisheries (*prud'hommes pêcheurs*) and sworn guards (*gardes jurés*), whose number is determined by the prefect of each district. The former are appointed by the prefect at the recommendation of the chief of the recruiting district. They must have been captains or owners of boats or vessels, and must possess some knowledge of the fisheries. They have to watch over the proper observance of the fishery laws, and assist in collecting statistical material. There is no salary connected with these places, but the time spent in these duties is counted in awarding pensions as time of service on board a man-of-war. Every one whose name is on the naval register is entitled to a pension at the age of fifty, after a service of twenty-five years, either on board or on shore, either on a merchant-vessel or a fishing-vessel in the service of the Government. For five years' service in time of war an extra pension is granted. The sworn guards are selected by the prefect from a number of candidates proposed by the captains of boats, double the number of men to fill the vacant places always being proposed. They must be twenty-five years of age, must have served as captains of boats for at least twenty-four months, and have been on board a man-of-war for two years. They are elected for the term of one year, but can be re-elected. After ten years' service, and if there is no complaint against them, they are entitled to a medal, which is worn on a blue ribbon. There is no salary connected with these places, except in cases where they have had a loss of time, when they receive a certain sum per day and traveling expenses. The time of service is, as regards the pension, counted as military service in time of peace. They have to watch over the proper observance of the fishery laws and call the attention of the inspectors to anything that will promote the fisheries. The freshwater fisheries are under the Ministry of Public Works.

ITALY.—There is no special administration of fisheries. The proper carrying out of the provisions of the fishery laws is intrusted to the ordinary authorities: to the navy, harbor-masters and inspectors, custom-house officers, forest guards, and, in fact, to any sworn officer un-

der the Government. Provinces, towns, or private individuals can, subject to the approval of the Government, appoint special officers to watch over the fishing interests. Such persons are duly sworn in, and in the performance of their duty have the same powers as police officers.

In Naples there is a zoological station (*Napoli Stazione Zoologia*) which, though a private establishment, is supported by international contributions. Germany contributes annually $7,236; and several other countries give a total sum of $8,040. For every student sent to this station an annual sum of $402 is paid. Italy has 6 students' places, Prussia 3, and Russia 2. In all there are 22 places. In 1884 an international subscription was taken up to buy a steamer for practical and scientific investigations in the Mediterranean.

ENGLAND.—There is no public functionary who has charge of the salt-water fisheries. They belong under the Board of Trade, which has special investigations made by commissioners or experts specially appointed for this purpose. The wish, however, has often been expressed in many journals to have the Government take charge of the salt-water fisheries.

During the last few years two private associations have been formed: the National Fish Culture Association, whose aim is to encourage artificial fish-culture; and the National Sea-Fisheries Protection Association, principally formed to protect the interests of its own members. An association formed in 1861—the Fisheries Preservation Association—aims especially at preserving the stock of fish. For the freshwater fisheries there are two inspectors, who are under the Home Office. There are numerous private associations and clubs for the preservation and promotion of the freshwater fisheries.

SCOTLAND.—From 1809 to 1882 the fisheries, principally herring fisheries, were under the Board of British White-Herring Fishery, composed of nineteen members chosen by the Government. They were selected principally from among the nobility and men of science, while men directly interested in the fisheries were excluded by law. The business was done by a secretary, who had his office, with five clerks, in Edinburgh. Under this board there was a general inspector, an assistant inspector, and 26 inspectors, some having assistants. At the disposal of the board there were several vessels, one of them belonging to the board, and the others furnished by the navy. The duties of the board consisted principally in branding the herring barrels, collecting statistics of the fisheries, and taking general supervision of the fisheries. Since 1828 the board has enjoyed an annual government appropriation of $14,472 for improving harbors. The conditions under which this appropriation is granted are that the work is done by the engineers of the board, and that the persons interested in the matter pay at least one-fourth of the expenses.

This board (whose members had no salary) did not prove satisfactory, and it was reorganized in 1882. Its official name was changed to Fish-

ery Board for Scotland. It is now composed of three sheriffs, who remain in the board as long as they hold the office of sheriff, and six other members, who are elected for five years. Three members constitute a quorum. All members of the board are appointed by the Government, which also appoints the president and secretary, each of whom has a fixed salary. The duties of the board were extended, and now it has charge both of the salt-water and salmon fisheries; and it is to promote the interests of the fisheries by all the means in its power. The revenue of the board consists principally in the tax for branding barrels. At present the board is having practical and scientific investigations of the herring fisheries made on a tolerably vast scale. An experimental station has been established at Granton, and it is the intention to establish a similar station on the west coast of Scotland. For the promotion of the freshwater fisheries a private association—the Scotch Fisheries Improvement Association—was formed in 1880. Besides this association there were also at the end of 1883 ninety-eight clubs or associations with the same object.

IRELAND.—Both the salt-water and the freshwater fisheries are under the Office of Irish Fisheries in Dublin. This office has three inspectors, each having his own district. There are, besides, one secretary, three clerks, and one engineer. The inspectors have charge of the administration of the fisheries in general, and are assisted by the coast guards. They can make regulations for the proper management, promotion, and protection of the fisheries, and are allowed to advance money to fishermen for purposes connected with the fisheries. In 1882 sums amounting in all to $42,880 were loaned to fishermen.

CANADA.—At the head of the administration of fisheries there is a director, whose office is under the Ministry of Marine and Fisheries. The following persons are appointed in the provinces:

In Quebec: One captain of the steamer, forty-nine overseers, and forty-nine guardians.

In the other provinces: One inspector in each, one overseer in every county, and one guardian in every township.

The total number of persons comprised in the administration of fisheries was the following in 1882:

Where employed.	No.
In Ontario	90
In Quebec	98
In Nova Scotia	241
In New Brunswick	109
In Prince Edward Island	46
In British Columbia	2
On board the steamer	30
At the hatching stations	25
Total	641

The sums expended for salaries amounted to $40,200, and for other purposes to $53,600 per annum. The inspectors and overseers have judicial power, except in cases where they are witnesses. The same power is delegated to every stipendiary magistrate and to every naval officer on board vessels engaged in the superintendence of the fisheries. Special officers are appointed to superintend the hatching of fish.

UNITED STATES.—There is a Commissioner of Fish and Fisheries, who is appointed by the President. The work of the United States Fish Commission is in three directions, namely:

Occupation.	Persons employed.
Scientific investigations	10
Hatching of fish	15
Statistics of fishing industries	6

The Commissioner has also an office for conducting the correspondence of the Commission. All persons employed in the Fish Commission are appointed by the Commissioner. For practical and scientific investigations he has two steamers, one of 385 and the other of 206 tons. During the fiscal year 1871–'72 the appropriation for the Fish Commission was $8,576, while in 1882'–83 it amounted to $230,212.

Most of the States have a commissioner of fisheries, who is appointed by the governor. There are persons appointed who have to see to it that the fishery laws are properly observed; and informers receive half of the fine imposed. In 1865 the different States spent for their fish commissions $6,566, and in 1882 $120,600. There is in the United States an association called the American Fish-Cultural Association, whose name was at the last general meeting changed to the American Fisheries Society.

XXVII.—THE FISHERIES OF SWEDEN.*

By Dr. Rudolph Lundberg.

The herring fisheries.—The herring fisheries are, on the whole, the most valuable of the fisheries of Sweden. In this respect, however, they have to compete with the eel fisheries, and on the west coast of Skane with the cod and flounder fisheries. To the fishermen of the west coast the herring fisheries are of special importance because they are carried on during only a small part of the year, and because the income therefrom comes more "in a lump," as the saying is. On the herring fisheries the fishermen rely for their stock of fish for the year, and the result of these fisheries is, therefore, of the greatest importance to the coast population.

Among the herring on the coast of Skane several varieties may be distinguished; and as these different forms of herring caused Prof. Sv. Nilsson, more than 50 years ago, to advance his opinion regarding the varieties or races of the herring, they are of special interest, and I therefore deem it proper to give a short account of the same, and dwell on the significance which it seems to me they possess.

The most important question to explain is how the herring, after the year 1808, disappeared from the coast of Bohuslän; and Professor Nilsson (who could not approve of the opinion which was prevalent during the last century, that the proper home of the herring was the Arctic Ocean, whence they emigrated to the more southern seas in enormous schools) arrived at a totally different conclusion, namely, that every basin of the sea had its own kind of herring, which had become stationary there and had consequently its peculiar character, or in other words had developed into a separate "race." As regards the Skane herring he distinguished[1] three races, namely, the "Kulla herring," the "Rabo herring," and the "Cimbrisham herring" or "Kivik herring." [Kulla, Rabo, &c., are names of different localities in Skane.] Later[2] he defined the first-mentioned variety as a sort of transition form between the "sea herring" and the "Baltic herring." The south-coast

* "*Meddelanden rörande Sveriges Fiskerier*," Stockholm, 1883. Translated from the Swedish by Herman Jacobson.

[1] *Prodromus ichthyologiæ Scandinavicæ.* Lund, 1832.

[2] *Skandinaviska Fauna,* p. 493.

herring and the east-coast herring he considered as the same kind, and called it the "Kivik herring." He thought that it formed the connecting link between the South Baltic herring and the "*strömming*" or North Baltic herring. Nilsson, however, has never given a proper scientific distinction to these different varieties. Among the contemporary Swedish naturalists his opinion was for a long time the only accepted one. Occasionally doubts were uttered as to the correctness of the hypothesis relative to the different varieties of herring, but these doubts were based not so much on special investigations as on mere supposition. For the last few years a German naturalist, Fr. Heincke,[3] has treated this whole question of the different races of the herring in the most careful and thorough manner. The result at which he arrived is that there are several varieties of the herring, and among these again some local kinds, therefore on the whole the same as Nilsson's opinion, although Heincke divides the races differently.

The question as to the races of the herring is doubtless an exceedingly difficult one, somewhat owing to the fact that the definition of the term "race" is by no means absolutely certain. During my journeys I have had occasion to give some attention to this matter, and during the last year I caused the superintendents of the fisheries to gather herring from the neighborhood of Kullen and from the east coast of Skane. I have, however, not been able to convince myself that among the herring from the Baltic and Cattegat, which I examined according to the method employed by Heincke, there are different races. It would require a separate treatise to give my investigation in detail, but I deem it proper to direct attention to various matters connected with the question of the varieties of the herring which deserve to be studied more than has been done hitherto. First of all it should be clearly understood what is meant by the term "race." Opinions are divided on this subject, but every one will agree with me that races in a scientific sense cannot be distinguished by a greater or less degree of fatness or a different flavor, or, in other words, by qualities which are taken into consideration when the herring are sorted as articles of merchandise. Care should also be taken not to consider as marks of differences of race those variations that are caused by the age of the fish; for if this was done herring of different ages would form separate races. It may with good reason be questioned whether the distinctive marks of the different races are not simply caused by differences of age, the greater or less development of the sexual organs, &c. Every one knows that in the Baltic there is found a smaller kind of herring (the *strömming*), and the opinion is very general that the *strömming*, which sometimes (especially when salted) has a different flavor from the common herring, must be another kind of herring. It is a fact that in the Baltic there are

[3] Fr. Heincke: "*Die Varieteten des Herings.*" I and II annual report of the commission for the scientific investigation of the German sea near Kiel. Vol. iv–vi, Berlin, 1878, and vol. vii–xi, part 1, Berlin, 1882.

likewise found herring as large as the largest Norwegian herring, which they resemble very much, and that these large Baltic herring are found not only here and there, but along the entire Swedish coast of the Baltic, though in comparatively small numbers, so that in many places they do not form the object of special fisheries, and consequently are not often seen in the market. These large herring cannot be anything else than old, full-grown specimens of the common Baltic herring. To consider these large herring, when found in the Baltic, as a separate, larger race of the *strömming* (as has sometimes been done) does not seem to be a satisfactory explanation. With the same reason pike weighing a number of pounds would have to be considered as a different race from those of light weight. These large herring are caught on our coasts early in the spring as soon as the ice begins to break, and in certain localities even in the middle of summer, when, at least in the northern portion of the Stockholm coast, they have been observed to spawn. It is stated that they are also caught late in autumn on the outer coast. On the Baltic coast of Skane these herring do not form the object of special fisheries, but, as an old and experienced Ystad fisherman told me, unusually large herring are frequently caught[4] there in autumn after a storm, and such herring are also caught in early spring during the salmon fisheries at Sandhammar. In answering the question of size of the herring caught on different coasts, the method of fishing and the size of the meshes of the nets should be taken into consideration, for it largely depends on these things as to what size of herring will be caught. In net fisheries the herring caught are of a tolerably even size, as fish of a larger size will not stick in the meshes because they cannot get their heads in far enough, while smaller fish will slip through the meshes. In seine fisheries, where also fish are caught which do not stick in the meshes, the case is different, and the fish caught will vary very much in size. In endeavoring to solve the question simply on the basis of the average size of the herring caught on a certain coast, there is great chance of arriving at an erroneous conclusion. Fishermen try to arrange their apparatus in such a manner as to obtain the greatest possible quantity of fish, but the majority of the fish caught are not large, but young and small ones, because most of them never reach a very great age. If large herring are not as a general rule caught on a certain coast, this does not therefore prove that no such herring are found near that coast, or that the herring of that region never grow any larger.[5] The actual facts show that the

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[4] They are caught in special nets, having 20 meshes to the yard.

[5] The objection may be made to what has been said above, that, as a general rule, none of the very large herring referred to are caught in the seine fisheries on the Baltic coast. This, however, is caused by the circumstance that the old herring do not spawn at the same time as the younger ones, and generally during spring and summer keep in deep water where they cannot easily be caught with seines. In winter some are occasionally caught in seines, because the old herring keep near the coast at that time, and in spring again go into deep water.

opinion that the large herring which are found in the Baltic retain the same characteristics which distinguish the younger herring[6] is erroneous. It is certainly true that the Baltic herring, or *strömming*, because they do not get such rich food, do not grow as rapidly as the North Sea herring, and are not found in such large quantities, and that, therefore, the number of full-grown fish in the Baltic must be smaller than in the North Sea; but it seems to me that this does not by any means prove that these herring, viewed from a zoological standpoint, must belong to separate races, even if, as articles of merchandise, they are considered as different kinds.[7] Accordingly, I cannot share George Winther's opinion[8] that in the Sound there are found no less than three races of herring, namely, a small variety spawning in spring, the Sound herring proper, which, "owing to its being confined in a small basin, never reaches any considerable size;" the Cattegat herring; and the Baltic herring; each of which come into the Sound from their original place of sojourn, and spawn in autumn. On the other hand, Winther may be perfectly correct in his opinion that the Baltic herring occasionally goes into the Cattegat and the Cattegat herring into the Baltic. Near Kullen and Torekov I have heard complaints that the genuine "Kulla herring" is not found there every year, but that its place is sometimes taken by smaller and leaner herring, which are supposed to come from the Baltic. Nothing but investigation carried on for several years can definitely decide this question. The only noticeable difference between the "Kulla herring," "Ystad herring," and "Cimbrisham herring," which I had occasion to examine, consists in this, that the first-mentioned herring have generally a smaller head in proportion to the length of their body than the last two. But, as Heincke has shown, the proportion of the head to the length of the body depends on the age, and is probably caused by the circumstance that the head, with its firm framework of bones, does not grow in the same proportion as the rest of the body.

The region in which the Skane fishermen carry on the herring fisheries extends in a northerly and westerly direction as far as the Falkenberg region and the Seeland Reef, and in a southerly and easterly direction through the Sound as far as Möen and Bornholm, and north as far as the Hano Bay. The most important fishing stations are near Hallands-Waedero and Kullaberg, Flintrannan, and the regions south of these localities as far as Skanor and near Bornholm, but herring are more or less caught along the entire coast. As regards the method

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[6] Nilsson's *Fauna Fiskarna*, see p. 512, where it is called a variety of the *strömming*. Nilsson's comparison between the great herring from Gefle and an equally large herring from the Cattegat (*Observationes Ichthyologicæ*, p. 11) was made between two specimens, one of each kind, and therefore does not prove anything.

[7] I have never heard it stated that the so-called "Halmstad salmon" and the "Baltic salmon" are of different races, although as articles of merchandise they are considered different.

[8] "*Om Sundets Silderacer*," in *Nordisk Tidsskrift for Fiskeri*, vol. ii, 1876.

employed in these fisheries, and the time when they are carried on, the coast of Skane may be divided into two districts, each of which has its peculiarities. The Falsterbo peninsula forms the boundary line between these two districts.

North of Falsterbo (that is, in the Cattegat and Sound) the so-called "*närdingar*" are used in the herring fisheries. This is a kind of net distinguished from the herring net used in the Baltic (the so-called "*mansorna*") principally by the fact that in the former the meshes are not fastened directly to the hanging-rope (Fig. 1, *b*), but run loose on a sort of hanging-twine (Fig. 1, *a*), which at every fourth mesh is fastened to the hanging-rope, so that there are three loose meshes between the points of fastening. The distance between these is called a "*skod*." At every sixth or eighth *skod* a cork float is placed. Half of the upper meshes are made of coarser yarn. The meshes are fastened in this manner all round the net, even on the side-line and anchor-line. At the corners the ropes are laid so that they form loops, by means of which the nets are joined one to the other when they are set. On the anchor-line there are so-called stone-ropes, to which the stones which hold the net are attached. In the Baltic herring nets, however, the meshes are fastened to the hanging-rope. The net is by means of tolerably long ropes fastened to a separate strong rope, to which the floats are attached (Fig. 2, *a*, *b*). Even in mackerel and cod nets the meshes are fastened in the same manner, and this arrangement gives to the nets a great degree of elasticity, which proves of great advantage when the fish push against them. Both the *närdingar* and the *mansorna* are used as bottom nets and as floating nets. In all the Skane fishing stations north of Helsingborg, bottom nets are used exclusively in the herring fisheries.

The difference between floating-net fisheries and fisheries with stationary nets is this, that in the first-mentioned method the net is fastened to the boat and allowed to float with the current, at a greater or less distance from the surface, while in the second method the nets are held to the bottom by grapnels.

The bottom nets which the fishermen employ in Skane north of Helsingborg are in a certain sense floating nets, as the nets are not so firmly anchored but that the current can drag them along the bottom; they are not, however, fastened to the boats.

In employing this method of bottom-net fishing the nets are set in the following manner: At one end of the row of nets there is placed, in order to hold it at the bottom, a tolerably heavy stone, weighing about 18 pounds or more. To an iron peg driven into this stone there is fastened a strong rope (Fig. 3 and Fig 4, *a* and *b*) running up to a buoy which marks the beginning of the net, and is called the "head buoy" (Fig. 3, *c*, and Fig. 5): and to this peg is also attached a short line three fathoms long, to the other end of which the net is fastened (Fig. 3 and Fig. 4, *b*). At every ninth net a thinner line is fastened, which runs up to a

smaller buoy (Fig. 3, *d*), while at the end of the entire row of nets there is again a large stone, from which a strong line runs up to a large buoy. These buoys, which indicate the place where the nets are set, consist of boat-shaped pieces of wood 2 or 3 feet long, which in front have an iron hook to which the rope is fastened, and at the back a short peg to which a stone is attached, to prevent the buoy from being upset (Fig. 5). To the upper side of each of the large buoys there is attached a twig, with a small flag or rag, or sometimes only a bunch of branches, at the top, so that it can be seen at a distance. In place of these buoys small barrels are also used (Fig. 6), and recently our fishermen have begun to use buoys made of cork disks (Fig. 7), which are considered better than barrels, because the barrels become leaky and thereby useless. South of Helsingborg and on the Baltic coast iron grapnels are used to hold the nets at the bottom, instead of the stone mentioned above. The method of fastening nets in the manner described above can be traced back to a very remote period.

The so-called *närdingar* are also used as floating nets, as was stated before, but this is done only in the Sound south of Helsingborg. It seems that this manner of using these nets has been introduced recently. During the famous Skanor fisheries in the Middle Ages floating nets were doubtless also employed, but probably the nets then in use were arranged in the same manner as the *mansorna*. As an old and experienced fisherman from the fishing station of Raa told me, the fishermen of that locality did not begin to use floating nets till the year 1838. They were generally cruising, their nets floating near the surface, partly off the coast of Raa and partly in the Ise-fiord. Not till 1842 did they begin to go as far south as Flintrannan. They learned this method of fishing from the Blekinge fishermen who came about that time as far as Malmö and began to fish near that coast. The Skanor fishermen fished prior to this time in the Flintrannan, but in 1838 they had only 3 boats with small, coarse, and tarred nets. Near Limhamn there was in 1836 only one fisherman. Even the *närdingar* were smaller at that time, as they were only 100 meshes deep, while at present they are 260, 300, and more meshes deep. Those which are used in the floating-net fisheries in the Sound are very long (from 50 to 60 fathoms), and are divided into two or three parts, which, when the nets are set, are joined together by a band. They are held up by small buoys (Fig. 8), generally with very short straps (only two feet long). The row of nets therefore floats quite near the surface of the water, which is almost necessary on account of the shallow water in the Flintrannan, as the net is almost three fathoms deep. On the Limhamn boats the number of nets used is generally 10. In that case there are next to the boat four *närdingar* with a buoy; these are followed by three *närdingar*, then again a buoy; and finally at the other end of the row of nets a buoy with a light (Fig. 9 and Fig. 10). The row of nets is attached to the boat by a line fastened to the first net. In calm weather this line is quite short (2 or 3

fathoms), while in rough weather it is somewhat longer (6 or 7 fathoms). In the northern part of the sound, between Helsingborg and the island of Hven, the Raa fishermen use sinkers to keep their nets a few fathoms (occasionally as much as 4 or 5) below the surface, which prevents their being disturbed by vessels. A peculiar difference between the method of setting the nets employed in the Baltic by the Blekinge and Skane fishermen and the method used in the sound is this, that in the last-mentioned method the net is paid out by using small sails on the boat, and that the row of nets is set against the current. The stones are previously tied to the ropes, and the nets are laid in a trough, ready to be paid out. All that has to be done, therefore, is to loosen them and let them run out. When the net is to be hauled in one takes hold of both lines and draws it into the boat over a roller fastened to the gunnel.

When the Blekinge nets, or so-called *mansorna*, are used, the mast is taken down and the boat is allowed to drift with the current; the stones are tied to the ropes while the net is set, which is not a very quick process, as the boat does not go any faster than current and wind will drive it. The row of nets is, therefore, often placed in a position lengthwise the current, which is not an advantage. When the net is hauled in it is drawn over the side of the boat by the cork-line. These nets (the *mansorna*) are generally 20 fathoms long and 3 fathoms deep. Barrels are not used as buoys, but blocks of wood pierced at one end. These nets are set near the bottom, off the coast, in spring and autumn. No stones are used, but iron grapnels, one of these to every fourth net. Each net has a small buoy, and at both ends of the row of nets there are large buoys.

The above will be sufficient to give an idea of the apparatus and method employed in the herring fisheries.

The so-called *närdingar* are, as far as I know, peculiar to the coasts of Skane and Halland, and seem not to be in use anywhere else.[9] In the Sound they can still be used as floating nets, but in the Baltic, with its greater depth, the fishermen consider the *mansorna* as better adapted to their purpose, as it is easier to let them down into deep water. The *mansorna* are also used in Blekinge and near Bornholm. Among the Swedish herring nets they resemble the Gothland nets, and among foreign nets those used by the Dutch in the North Sea; although our nets are of course not nearly so deep and are not made of as strong twine. Our Swedish fishermen do not use a hanging-rope to which all the nets are attached, but make the cork-rope do service instead; and the hang-

[9] It deserves to be mentioned that in the fishing stations near Kullen the nets are not colored or tanned, because it is alleged that when used as bottom nets they will attract the fish less than the light-colored nets. Whether there is any reason for this I cannot state, but according to Collin (*Nordisk Tidsskrift for Fiskeri*, vol. i, p. 353) the Danish fishermen are of the same opinion. In all other places the nets are colored by being dipped in a decoction of birch bark and soda. Near Raa they count a *kanna* (about 3 quarts) of bark and about 9 pounds of soda to each net, and enough water to dip the entire net in it.

ing-twine is attached only to the nearest net. For our circumstances the apparatus described above is doubtless the best. In the Baltic deeper floating nets can be used, but with our small boats they are difficult to handle. From what has been said it appears that on the Skane coast of the Cattegat and the Sound so-called *närdingar* are used, which on the coast north of Helsingborg are exclusively used as bottom nets, while in the Sound they are also used as floating nets. On the Baltic coast of Skane the *mansorna* are used exclusively, both as floating nets and as bottom nets.

Even with regard to the fishing boats each coast has its peculiar type of boats. Skane, however, has no boat peculiar to that province. The Skane fishing boats show three forms. The Sound boat is principally used in the fishing on the Cattegat and the Sound; the Bornholm boat, which gradually begins to come into use on the east coast of Skane and seems destined to take the place of the third form; the Blekinge boat, which, however, is still in general use on the south and east coast of Skane.

At present the Sound boats are generally covered, with the exception of the Torekov and Mölle boats, which even when of considerable size are open, because they are also used for carrying lumber, &c. The smaller boats, however, are all open, as is the case with all the fishing boats used on the east coast of Skane. Most of the Sound boats are at present built at Viken, north of Helsingborg. Their general dimensions are as follows: Length from stem to stern, 30 feet; length of keel, 19.5 feet; breadth back of the mast, 12 or 13 feet; depth of hold, 4.5 feet; height of the mast, 32 feet. Generally they have only one mast, with a boom and jib. They also have a top-sail, fastened to a pole attached to the top of the mast.

A common open Bornholm boat, such as is used on the east coast of Skane, measures 26 feet from stem to stern, by 3 feet in breadth back of the mast, and has a hold 4 feet deep. Their sails are, as a general rule, like those of the Blekinge boats. These boats are built in Bornholm.

The Blekinge boats vary in size, the largest ones being of the same size as the Bornholm boats. They have only one mast and one square-sail, which can be hoisted and let down very rapidly. They are good sailers, but there is always some danger of their being upset.

It will be hard to say which of these three forms is the best, as each has its peculiar advantages and disadvantages. It applies to boats as well as to fishing apparatus, that even a poor boat, in the hands of a person who understands how to use it to the best advantage, can do better service than a more perfect one whose advantages are not fully understood. On the east coast the open boats will doubtless gradually be replaced by covered boats, which are an absolute necessity for the salmon fisheries in winter.

The total number of boats belonging to the Skane fishing stations in

1882 was 1,581, and the average price was as follows: Covered herring boats from 300 to 1,200 crowns [$80.40 to $321.60], and open herring boats from 150 to 1,200 crowns [$40.20 to $321.60].

The herring fisheries on the Baltic coast of Skane generally begin early in spring, and the time of course varies according to whether spring is early or late. The beginning is made by setting bottom nets near the coast in March or April. At that season of the year it is still too cold for the men to stay out at sea in open boats during the night, and the floating-net fisheries therefore do not begin till the end of April or during the first half of May, and at some fishing stations not till the beginning of June. Floating-net fisheries are then carried on all through the summer till September, when they come to an end, and bottom nets are again used near the coast for catching spawning herring. These last-mentioned fisheries are continued till the autumn storms bring them to a close. The sea near this coast is very rough, and during a storm the waves are high. The spawning-herring fisheries, especially in spring, are not very important, and the best fishing season is generally in summer (during July and August). In August the fisheries are frequently hindered by the "blooming of the water," as the fishermen call it, large masses of algæ (of the family *Nostochaceæ*) filling the water. The fish avoid the places where these algæ are found, and prefer to stay in the open spaces. Herring spawning in spring are caught principally at the fishing stations near Blekinge, and they become more scarce the farther south one goes. According to the statement of the fishermen, several years may pass without any such herring making their appearance. Nilsson says that these herring are somewhat smaller than those which spawn in autumn, but are otherwise exactly like them. The Sound herring which spawn in spring, and which Winther considers as a race of herring peculiar to the Sound, are generally small herring. The Swedish fishermen on the coast of the Sound have no knowledge of herring which spawn in spring in these waters, and in no portion of the Swedish side of the Sound do the spring herring form the object of any very important fisheries.[10] It is true that some small herring are caught all the year round, principally to supply bait for line-fishing, but the herring fisheries proper in the Sound and the Cattegat do not begin till the middle or end of August or the beginning of September, and last

[10]According to statements made to Dr. Schagerström by fishermen, the herring spawn in the Sound near Landskrona, as early as March. This statement, however, is not absolutely reliable. G. Winther states that on the Danish side of the Sound the spawning season occurs about the end of May, when small spawning herring are caught between the islands of Amager and Seeland. These herring are doubtless nothing but young herring. It is a common occurrence with other fish than herring that the fry and young fish keep near the land, and it is difficult to understand why with the herring this peculiarity should give rise to the opinion that these young fish are a separate species of fish. As the herring spawn very early in life, when measuring only 190 or 200 millimeters, the circumstance that herring spawn is no reason why they should not be young herring.

till the middle or end of October. The majority of the herring caught are not at the height of their spawning period; *i. e.*, they are full of roe and milt, but these are not fully matured or in a flowing condition. I have been assured that spawning herring are very rarely caught during the fishing season proper, but that after the close of the fisheries late in autumn, at the end of October or the beginning of November, schools of these herring seek shelter near the mountainous coast of Kulla, especially when the wind is north, and are then caught near the coast. These fish are salted and are used by the fishermen themselves. That the herring are thus caught before they spawn is of the greatest importance for their market value; and the herring from the west coast of Skane—the "Kulla herring"—have from time immemorial enjoyed a very high reputation, and have always brought good prices.

In dividing the fish which have been caught, there is this difference between the east and the west coasts of Skane, that on the west coast the division is made according to the number of nets belonging to a boat, while on the east coast every one takes whatever fish stick in his net. Each one takes his turn in setting the net. Other persons besides the population of the fishing stations take part in the fisheries; in West Skane, however, this is the case only during the herring fisheries. Old sea-captains, and widows of captains or of fishermen, keep a boat and net, or either, and hire people to engage in the fisheries. These people get half of all the fish they catch. Near Mölle, the owner of the boat, who is always the mate, receives for two nets two shares more than the other fishermen. If, for example, there are six nets, the owner receives eight shares, and, besides, every eleventh crown when the fish are sold. The number of the crew varies according to the size of the boats, from five or six to ten men, and one or two boys. These boys in the first year receive one net share, and in the second year two. They also get those herring that fall off when the net is hauled in and which are dipped up with hand-nets. Every fisherman has a girl as an assistant, who mends and dries the nets and pulls the herring from the net, for which she gets her board and one net share. Every boat has two extra nets, and the fish caught in these fall to the share of poor widows and children.

Near Viken, when the owner of the boat supplies the buoys and the lines, he gets a whole share, otherwise only half a share per boat. If the girl (who acts as assistant) has a net, she gets whatever is caught in it, otherwise she receives half a net share.

At the fishing stations on the south coast, where the crew generally are only two or three men per boat, who have equal shares in the boats and nets, they divide all the fish which are caught evenly among themselves. On the east coast, near Skillinge, the boat owner gets one man's share. The girl gets whatever is caught in a net which is set specially for her. As has already been mentioned, the fish caught

are not divided according to the number of nets, but every fisherman takes whatever fish have been caught in his net.

The fishermen have therefore, besides the expense for buying and repairing boats and nets, various losses from their income derived from the fisheries, so that the net income is not quite so large as would seem at first sight.

The fishermen of the Kulla region never stay near their nets over night, even if the weather is fine, but sail home as soon as they have set their nets, and go out again early in the morning to haul them in. It of course depends on wind and weather how early they come home with the fish. Frequently they do not get home till noon, and even later. As soon as the boat touches the shore, the nets are carried on land in their troughs, and are spread out on a sort of pavement specially made of small stones. The women then take off the fish. The fishermen carry the dry nets down to the boat, and after eating a meal they again go out to set their nets. Especially in the beginning of the fisheries, when the weather is still warm, it does not improve the herring to let them lie on the ground exposed to sunshine and rain. At all the Skane fishing stations the fish are sold exclusively in a fresh condition.

The herring dealers come with horses and wagons to the fishing stations, and the herring which they buy from the fishermen they take farther inland, where they are sold wherever a chance offers. The country people salt their own supply of herring for the winter. In August, while the harvest is still going on, the farmers have no time to salt herring, and in fact would not do it at all during the dog-days. At that season of the year, therefore, the sales are not so large, and the number of buyers is smaller. Under these circumstances it may happen that when the boats which come home late bring in a considerable quantity of herring (from 16,000 to 24,000) a great fall in prices is produced thereby, so that sometimes 80 fish (a so-called *val*) will bring 2½ crowns [67 cents] in the morning and only from 25 to 50 ore [6.7 to 13.4 cents] in the evening, which gives rise to stories of enormously rich catches and low prices, and tends prematurely to lower the price of herring. Under such circumstances the fishermen must sell at any price they can get, because they cannot, without neglecting their fisheries, sail to more distant markets, and because the herring would suffer if carried for any great distance. During the good herring years it would certainly pay on the coast of Skane to establish salt-houses and smoke-houses; and the competition which would be a natural consequence would prove an advantage to fishermen. It is difficult for some of the simple-minded fishermen to understand that the price of herring, like that of any other article of commerce, must be regulated by the supply and demand, and one often hears the wish expressed that the price might be regulated by some law, so as not to go below a certain minimum. There has been considerable difference between

the average price of herring on the east and on the west coasts of Skane, which is hardly sufficiently explained by the better quality and greater size of the Kulla herring (on the west coast). It is to be hoped that the easier communication with the interior by means of the recently opened Cimbrisham railway will create a better market for the fish caught on the east coast of Skane. That the construction of railroads has already exercised a beneficial influence on the income derived from the fisheries has been fully demonstrated in other parts of Skane. Thus old fishermen from Ystad have assured me that since the opening of the railroad the fisheries are continued later into autumn and are carried on far more energetically than formerly. Besides the herring which are sold on the spot, fresh fish are every day sent by railway to Malmö, and, slightly salted, as far as Estof and Jönköping.[11] The same will doubtless be the case on the east coast as soon as better means of communication are provided.

The herring on the east coast of Skane are of exactly the same kind as the so-called Bornholm herring, and if carefully treated they could doubtless bring a better price and find a more extended market than is the case at present. The experience of Blekinge and Bornholm is a sufficient guaranty for this. Besides other difficulties (as that the best herring are caught during the hottest part of summer), the efforts to give the Baltic herring a good reputation are counteracted by the circumstance that spawning herring unsuitable for salting are often introduced into the market under the same name as the better kinds of herring, which decreases their reputation and price, and throws difficulties in the way of persons who are desirous of preparing a better article. If the Skane salt herring are to get a better name and more extended market, it is absolutely necessary to introduce a better system of sorting the herring and of stamping the barrels. It is also very desirable that our business men should give some attention to the matter. It is hardly to be expected that the Skane fisheries can be made to compete successfully with the great fisheries of the world; but that they deserve greater attention, and that business men will here find a fruitful field for enterprise, will be seen from the following data:

Years.	Number of herring caught on the coast of Skane.	Income from the Skane herring-fisheries.		Number of fishermen, nets, and boats.		
		Crowns.	Dollars.	Fishermen.	Nets.	Boats.
1879	34, 333, 280	374, 784	100, 442. 11	2, 166	35, 365	520
1880	77, 768, 320	604, 161	161, 915. 14	2, 303	36, 569	786
1881	72, 267, 280	641, 191	171, 839. 18	2, 437	38, 334	758

Unfortunately we do not possess data from a sufficient number of years to show the changes to which the herring fisheries have been sub-

[11] In Ystad there is a smoke-house, owned by a German, and smoked herring and eels are exported thence to Germany.

ject. From the information obtained from old fishermen it appears, however, that such changes have always taken place. The following data from Raa, in the central part of the Skane Sound coast, and from Limhamn, in the southern part of the same coast, have been obtained independent of each other. N. Björk, an old Raa fisherman, states that from 1866 to 1868 there were very good herring fisheries in the Sound, the best that he can remember; the herring were small, and sold for 25 ore (6.7 cents) per 80 herring; and that they gradually increased in size till 1872, when the herring fisheries came to a close. In 1871 the greatest number of herring caught in the Sound were caught near Raa, but not one-fourth the number caught in 1868. In 1872 no herring were found in the Sound, and the Raa fishermen had to go as far south as the Danish island of Möen in order to catch fish. Several Limhamn fishermen have stated that during the period from 1867 to 1869 there were very good small-herring fisheries, while in 1870 the herring were somewhat larger, and in 1871 considerably larger; from 1873 to 1875 the fisheries were very poor; in 1876 and 1877 there were some fisheries; in 1878 and 1879 the fisheries were tolerably good; and in 1880 and 1881 they were very good.

In his treatise on the species of herring in the Sound, Winther states that after some years' poor fishing, the fisheries became very good in 1867, when a large number of small herring made their appearance in the Sound, and increased in size till 1873, when the majority of herring were large. They grew still larger in 1874, and after that year disappeared from the Sound, so that in 1875 only a small number of little herring were caught. Another Danish author, J. Collin, states that in the Sound, north of Helsingör, the best herring-fisheries of recent times occurred in the period from 1865 to 1870, the climax being reached during the years 1867 and 1868. Similar rich fisheries occurred in 1836, and in 1848 and 1849.

It is a well-known fact that good years alternate with bad years in the fisheries; but not till the Norwegian naturalist, Axel Boecks, made the history of the Norwegian spring-herring fisheries the subject of exhaustive investigations, was an actual periodicity in the appearance of the herring fully demonstrated. A similar regular increase and decrease of the fisheries was assumed for the Sound herring-fisheries by Winther. He presumed that the length of each period was about eight years, counted from the best year, till the fisheries again became poor. According to his calculations there were poor fisheries for two years, showing, however, a tendency to become better; then four years good fisheries, followed by two years poor fisheries with a tendency to become worse. By continuing these statistics for a considerable number of years it could be shown whether the actual facts bear out Winther's view.

It is a noteworthy fact, mentioned by all our informants, that the herring towards the end of good fish years increase in size, decreasing at the same time in number from year to year, until they disappear

entirely. In explanation of this circumstance Winther states that the small Baltic herring, which in 1867 came into the upper part of the Sound in large numbers, found that the deep basin south of the island of Hven was no longer inhabited by the large Sound herring. The Baltic herring therefore remained in that locality, increasing in size from year to year till they reached the size of the Kulla herring, when they became too large for the Sound and went out into the Cattegat. This explanation, however, is hardly satisfactory, as it is well known that the herring from the Cattegat and the Baltic enter the Sound every year towards the beginning of the spawning season in autumn, that at no other season are there any important herring-fisheries in the Sound, and that at other times no large herring whatever are caught there.

The recent changes in the Skane herring-fisheries naturally have drawn attention to the rich fisheries near Skanor and Falsterbo during the Middle Ages, and it may be of interest to state briefly what is known relative to these fisheries, and how they compare with the present Sound fisheries.

In the *Knytlinga Saga* (written in the beginning of the thirteenth century) it is stated that Canute the Holy (died 1086), during the war with the Skanians, brought them into subjection by threatening to exclude them from the herring fisheries. Saxo, in his Danish History (written soon after 1206), relates: "At that time there was such an enormous number of herring in the Sound that they could be caught with the hands, and it was almost impossible for a boat to make its way through the dense masses of fish." During the first years of the thirteenth century the Germans seem to have taken a share in the Skane herring-fisheries. According to the historian Hvitfeld, the Lubeckers, in 1203, obtained the privilege from the Danish king, Waldemar Seier, of engaging in fishing, and they were to begin on the coast of Skane. According to Sartorius (a German historian) they did not secure these privileges in due form till the year 1343. These privileges were confirmed in 1365, when their right to carry on a retail trade was taken away and not restored till 1370. The most important provision of these privileges, according to Sartorius, allowed the Lubeckers to sell cloth, linen, &c., by the yard; in other words, to carry on a retail trade, a privilege but rarely granted to foreigners. During these troubled times, and during the reigns of worthless kings, the Hanse Towns succeeded in getting the entire control of the Skane fisheries and trade. The principal trading and fishing stations were Skanor and Falsterbo, and also Ellenbogen (the present city of Malmö). Here large markets were held during the autumn herring fisheries. The Danish historian C. F. Allen estimates the number of persons who at that time visited the coast of Skane at from 60,000 to 70,000. Another Danish historian, Styff, says that at Skanor and Falsterbo the so-called Biscay fleet, on its return from the southwest of Europe, met the mer-

chants fromPrussia and Livonia. All the important sea towns belonging to the Hanseatic League, from Kampen and Harderwyk, on the Zuyder Zee, as far as Reval, on the present Baltic coast of Russia, had lots on the Skane coast, where they erected booths and stores. At a certain season of the year the Hanse Towns sent prefects to the coast of Skane to defend their old rights and privileges. The Danish kings appointed a person both at Skanor and Falsterbo to see to it that their rights were not infringed upon. The Hanse prefects, however, stood their ground, and within the districts controlled by them no foreigner was allowed. No German was to salt herring for the King, Danes, or other foreigners; nor were the Hanse men to let their herring be salted by foreigners. According to their privileges they were to have full liberty to carry on the fisheries, to have their own workmen, &c. Sartorius states that the Hanse merchants even seem to have prevented foreigners from obtaining good barrels, with the view to limit their sale of fish. At that period the Hanse Towns controlled nearly the entire trade of the north of Europe, and it was very difficult for the inhabitants of Scandinavia to compete with them. It was forbidden to salt herring on board vessels, in order to prevent smuggling. The duties paid to the Danish Crown, however, were ludicrously low. All herring exported from Skane by way of the Sound were free of duty. Besides the duties, the King had the right of the so-called "royal purchase;" that is, every fisherman, no matter whether he fished on his own account or for others, must sell to the Crown 240 herring at half the ruling price. For curing these fish the Danish Crown maintained large salt-houses at Skanor, Falsterbo, Dragor, and on the island of Möen, and from the accounts kept at these establishments we get our data relative to the yield of the herring fisheries. According to Allen, there were in 1518 salted in the royal salt-house at Dragor 180 *tunnor* [= 297 hectoliters] of herring. F. Trebban, the royal superintendent at Falsterbo, in his report to King Christian III for the year 1537, states that at Falsterbo there were salted 96,000 *tunnor*, or barrels [= 158,400 hectoliters], of herring, and estimates the entire number of herring caught in the Danish Monarchy during that year at 360,000 *tunnor* [= 594,000 hectoliters]. According to the report of the Lubeck prefect at Falsterbo, the number of persons engaged in the Skanor and Falsterbo herring-fisheries during the first years of the reign of King Frederick I [1523–1533] was 37,500, and the number of boats employed by them, 7,515. The average price of one *tunna* of herring [= 1.65 hectoliters] was 2 florins. The above-mentioned quantity of herring would therefore represent a value of 720,000 florins, or 1,440,000 ounces of silver, an enormous sum, says Allen, if we take into consideration that silver was worth more than it is nowadays. According to Hallenberg, a barrel of Skane herring in 1539 cost 16 Danish marks [$3.21]. The value of the entire Danish herring-fisheries calculated on this basis would have amounted to 4,320,000 crowns [$1,157,760]. If we consider that

the Danish sea fisheries yield about 5,000,000 crowns [$1,340,000], of which a very large percentage doubtless belongs to the herring fisheries, the above-mentioned sum does not seem so enormous, when compared with the present fisheries, as Allen supposes. From the statement that 92,000 barrels [151,800 hectoliters] of herring were salted in Falsterbo alone, we cannot draw any conclusion as to the quantity of herring caught in the Sound and on the eastern coast of Skane during the great fisheries; and as we have no data from the Danish side of the Sound we are also unable to calculate how many are caught at the present time. Without fear of exaggeration, the quantity of herring caught on the Danish side in 1881 may be estimated at at least 50,000 *tunnor* [82,500 hectoliters]. If we take into consideration that the salting business was during the Middle Ages concentrated in a few places, on account of the customs duties; that owing to the presence of numerous foreigners the number of boats and fishermen was considerably larger than it is now; and that, if the circumstances were the same, as many herring would be caught nowadays during good years, it seems probable that the quantity of herring which came near the coast during the Middle Ages was not so much larger than it is at the present time, even if the data from those times are not exaggerated. Several circumstances seem to favor this view of the relation which the fisheries of our times hold to the so-called "great fisheries" of former centuries.

The natural conditions on the coast of Skane were nearly the same then as they are now. Styffe remarks that even in those days the water near the coast was very shallow, so that large vessels (though large merchant vessels like those of the present time were unknown) had to anchor some distance from the coast in the so-called Holeviken, and nothing but boats could come up to Skanor. The location where the fisheries were carried on was the same as it is now. Allen says that the fisheries were carried on in the Sound south of the island of Hven, off Malmö and Skanor, on the south coast, and later near Bornholm. The season for the fisheries was the same as it is now, and they were carried on exclusively in autumn. They began on the 10th, 15th, or 24th of August and continued till the end of October, probably extending into that month as much as they do now. According to the old Skanor law, no fisherman had the right to leave the coast before the 9th of October. That the fisheries then as now generally began in good earnest by the 1st of September seems probable from the fact that the market was not properly opened till September 8, and lasted till November 1. There is therefore nothing to show that the circumstances were different in these respects from what they are now.

That the fisheries even in those times were subject to considerable changes appears from the information which we possess. Allen states on the most reliable authority that the Sound herring-fisheries were unusually good during the period from 1482 to 1495, particularly during the years 1492 and 1493, when a number of fish, owing to the lack of

salting-vessels, had to be thrown away. Other writers state that the fisheries were poor during that period, and that about the year 1434 the herring left the Baltic and went to the North Sea. Both Sartorius and Allen, however, doubt the reliability of these last-mentioned statements; and Sartorius says distinctly that the best authorities do not speak of any interruption of the herring fisheries or mention anything regarding a decrease of the herring.

By a special agreement between Denmark and Lubeck the Hanse Towns in 1560 lost their privilege of carrying on herring fisheries on the coast of Skane, and therewith the great herring fisheries came to an end. This circumstance, that the herring should have disappeared at the same time when the Hanse fisheries came to a close, seems so strange that serious doubts have arisen in my mind as to whether the so-called "great fisheries" were really so enormous in comparison with our present fisheries as has generally been supposed. As late as the year 1530 (as appears from the report of the Lubeck prefect for 1537) the fisheries were very good, and nothing is said regarding a decline towards the end of that period. But about that time the Hanse Towns lost their commercial supremacy in the north of Europe, and about the year 1560 they had lost their foothold in most places in Scandinavia, and could not regain it in spite of strenuous efforts made by them during the war which followed soon after.

As Styffe remarks, Skanor and Falsterbo have never been towns of importance, but simply trading places. "Between the great market seasons but little business was done, and the number of permanent inhabitants was very small," says Styffe. He also directs attention to the fact that it was not merely the fisheries, but the general trade, which attracted the Hanse merchants to Skane, and probably trade was the greater attraction of the two, which explains the fact that they continued to visit the coast of Skane even when the fisheries were poor. It will easily be understood, however, that when the Hanse merchants, who controlled considerable capital for fitting out boats for the fisheries, left the coast the fisheries would decline, being left entirely in the hands of the sparse and poor coast population; while it is highly improbable that the herring left the Skane coasts at the same time with the Hanse merchants. It will also be difficult to find any instance where fisheries were successful on a coast for over three hundred years, and then became poor for several hundred years. That the Skane herring-fisheries became less important, and are after that period rarely mentioned by the historians, cannot, in my opinion, be ascribed to the circumstance that the herring left the coast, but to various other causes, principally to the fact that, owing to the want of capital and energy, the fisheries were no longer carried on in the same spirit of enterprise as was the case when the Hanse merchants managed affairs. When the country became more cultivated, other industries began to spring up, and the fisheries lost much of their former importance.

It is natural that the coming together of so many people made it necessary to have proper rules and regulations. According to Schlyter, the first rules of this kind were made by King Waldemar Atterdag (1340–1375); the exact year, however, is not known. A fuller code was promulgated by Erik of Pomerania, and Queen Margaret (1396–1412). The few data we possess relative to the manner in which the fisheries were carried on in those days are taken from these and other laws of that period.

As at the present time, the fisheries were carried on partly with floating-nets and partly with bottom-nets. It was strictly forbidden to stretch a net from the surface to the bottom so as to hinder the herring from reaching other nets. It seems that each fisherman could have only a certain limited number of nets. We find in these laws many regulations to prevent the exportation or sale of herring without paying duty to the Crown. Thus it was prohibited to salt herring on board vessels or boats or on the strand; no herring could be sold on the shore or carried away from the shore in sacks or baskets, but must be conveyed in carts and wagons, each having a full load. It was forbidden to take up bottom-nets except in the day-time, or to leave the port at night-time. It was strictly prohibited to put any damaged herring into the barrels; and any woman who threw the herring direct from the troughs into the barrels, instead of laying them carefully, had to pay the death penalty. According to Allen, King Hans in 1508 ordered the Dantzic fishermen to use only the fine white Lüneburg salt instead of the "Bay salt" (salt from the region of the Loire in France) and other coarse salt, from the use of which the Skane herring had become of poorer quality from year to year. The Dantzic fishermen, however, did not obey this order, and King Hans, who was engaged in numerous wars, did not find time to enforce it.

The sprat (*Clupea sprattus*) is certainly found near the coasts of Skane, but, with the possible exception of the Cattegat, not in any considerable quantity, and does not to any great extent form the object of fisheries.

THE EEL FISHERIES.—These fisheries are remunerative on the east coast of Skane, and in several places exceed the herring fisheries in importance. The fishermen distinguish three kinds of eels, but only two of these are of any importance, namely, the so-called "*drif* eel" (or "*blank* eel") and the "grass eel." The former are taken mainly with the *hommor*, a kind of fish-basket, and the latter are taken near the coast all the year round, but these last-mentioned fisheries are comparatively of little importance. The *drif* eel is distinguished from the grass eel by being larger and fatter, and principally by being white or silverish gray on the belly, while the belly of the grass eel has a more or less yellow color, and is also smaller and leaner. The *drif* or *blank* eel is (as I have shown in my treatise "*Om Ålfisket*," &c., in "Transactions of the Royal Agricultural Academy," 1881) an eel which comes from fresh

water and is going to its spawning place. In going over all the observations regarding the *hommor* eel fisheries on the Baltic coast of Sweden and in the sounds and the belts, we find that this is the actual fact, as shown by the very way in which the apparatus is placed, and the time when the fisheries are carried on. The *hommor* on the east coast of Sweden are so set that the eels must come from the north; on the south coast of the Skane, so that they must come from the east; and in the Sound and the belts, from the south. As in the last-mentioned localities the eel fisheries commence much later than on the east coast of Sweden, it may be considered as certain that the eels really travel along the coast to the more salty waters of the Cattegat; and, as this migration takes place at a certain season of the year, it is in the highest degree probable that it is in some way connected with the propagation of the eels, although for the time being we do not know where and how the propagating process is carried on. By the discovery made by Syrskis in relation to the male generative organs of the eel, and the discovery by Hermes of these organs in the male of the sea-eel (*Conger vulgaris*), it has been settled beyond dispute that both sexes are found among the eels, and that eels do not give birth to live young ones, as was thought in former times. Some progress has therefore been made toward solving the old problem of the propagation of the eel. That the eel for this purpose seeks salter water is as easily explained as that other migratory fishes, as the salmon, seek fresh water for the same purpose. The circumstance that this migration of the eels is noticed mainly in these portions of the Baltic which are nearest to the Cattegat is easily explained by the fact that eels from different localities must gather here in considerable numbers. The objection might be made that in that case the richest eel-fisheries must be in the Sound and not on the east coast of Skane and Blekinge; but it should be remembered that the nature of the coast, the currents, &c., doubtless exercise a considerable influence on the eel fisheries, and that on such circumstances it will principally depend whether, in their migrations, the eels come so near the coast that they can be caught with *hommor;* and also that the considerable eel-fisheries which take place before the eels reach the Sound must certainly decrease their number, as eels are not found in such enormous schools as herring and cod. The eels in their migrations pass the two northernmost fishing stations on the east coast of Skane, namely, Tosteberga and Landon, but are caught along the entire east coast as far as Sandhammar. On the south coast the eels go as far as Kaseberga, but no eels are found near Ystad, which is explained by an old Ystad fisherman, who says that along that part of the coast the eels go farther out at sea. Some eels are caught near Smyge and Bedinge, but going west no eels are found until the Kampinge Bay and the south side of the Falsterbo Peninsula are reached. On the west side of this peninsula and in the Holeviken (Hole Bay) north of it, no "blank eels" are found, and the same is the case at all

the fishing stations on the Swedish side of the Sound as far north as Raa, where eel fisheries are carried on with *hommor*, and along the coast as far north as Viken. North of that place there are no more eel fisheries. Of late years attempts have been made to carry on eel fisheries with *hommor* near Landskrona and also in the Schelderviken (the Schelder Bay), but without any success whatever. At Mölle, near the Kullen promontory, it is thought eel fisheries with *hommor* could be established if the bottom was more suitable for the purpose, so as to allow the *hommor* to be put in position; but the reason why the attempts made near Landskrona proved failures was not the nature of the bottom, for there it is well-adapted to the purpose, but simply the fact that the eels in their migration through that and the southern part of the Sound do not go along the Swedish coast, but along the Danish coast where the water is shallower, and where eel fisheries with *hommor* are carried on from the neighborhood of Copenhagen as far north as Helsingör. I have been informed by fishermen that such fisheries are also carried on in the Bay of Kjöge (south of Copenhagen).

What can be the reason that the eels during their migration pass by certain portions of the coast? Probably several causes contribute toward this result. If one observes the nature of the coast in those places where eels come near it, it will be found that these places are either in the offing or along an open coast. The eels ascend toward the coast from the depths, come close to the shore, pass along it for some distance, and again return to deep water. The best places for eel fisheries are in bays toward promontories which turn toward the places from which the eels come. A glance at the map will show that there are eel fisheries in the province of Blekinge near Horvik, and in other places of the peninsula of Listerland, but not in the Bays of Hellevik and Solvesborg. On the coast of Skane the eel fisheries commence at Åhus and extend south of that place, the best place for catching them being in the shallow bay extending from Åhus to Stenshufvud. Outside this bay which is passed by the eels there are many small islands. If we get to Falsterbo, we find that the best eel-fisheries are in the Kampinge Bay and along the south side of the Falsterbo promontory, but from that point the eels take a westerly direction and go toward the Danish coast. That the eels do not go over from the Bay of Kjöge to the Malmö coast is easily explained by the fact that they follow the shallow channel between the islands of Amager and Saltholm. The explanation given above, why the "blank eels" do not approach the coast near Ystad, or that the eels in ascending toward the shore turn back again when they find shallow water farther out, seems to be justified, and is also confirmed by information furnished by Grisleham fishermen. They state that the best places for catching eels are always on the north side of promontories; and the farther these jut out into the sea the better will be the fisheries.

Besides the "blank eel" and the "grass eel" the fishermen distinguish

a third variety, the so-called *slukålen*, which has a dark color, a broad nose, and tolerably large protuberances on the sides of the head, producing a furrow which runs along the middle of the head, and gives the fish an ugly appearance, for which reason it is also called *grymål*—the "ugly eel." This variety is found among the other eels, but not in very large numbers, and does not give rise to any special fisheries.[12] The "grass eel" and the "ugly eel" are exceedingly voracious, and remnants of fish are often found in their stomachs. The "horn eel," on the other hand, has generally an empty stomach, or only some reddish-yellow slime in it, so that it seems that, like the salmon and some other fish, it eats nothing or but little during its migration. Near Oro, on the Kalmar coast, where many eels are salted, and where they therefore have to be cut open, it was noticed as peculiar that nothing was ever found in the stomach of a "blank eel;" while the reverse was the case with the "grass eel." The few observations which I have made regarding this subject confirm this. These facts still further corroborate the opinion that eels do not come near the shore to seek food, but that herein they resemble the salmon, which on their journey toward the rivers also go along the shore. There is no doubt that a large number of the migratory eels come from fresh water, but a large number of eels are found in the Baltic near the shore and in the inlets all the time, and are caught there all the year round.

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[12] As regards the relation between these different varieties of eels, opinions are still divided. Yarrell and some older zoologists give them as separate varieties. Among the Scandinavian naturalists Ekström distinguishes two varieties, the large-nosed (*Murœna platyrhina*) and the small-nosed eel (*Murœna oxyrhina*). Króyer distinguishes three kinds: *Anguilla migratoria*, *A. acutirostris*, and *A. latirostris*. In Nilsson's Fauna these are given as varieties of the common eel. Günther in his large work, "Catalogue of Fishes in the British Museum," says that of all these varieties only the *Anguilla latirostris* can be considered as a separate kind, principally because the proportion between the length of the fins and the length of the head is very different from that found in the other eels. With the common eel the length of the head is equal to or less than the distance between the roots of the dorsal and of the anal fins, while in the *Anguilla latirostris* the length of the head is greater than the above-mentioned distance. I have examined a few (10) specimens of Skane eels. No. 5, which, as regards the position of the fins, resembles the *Anguilla latirostris*, had a very pointed nose. No. 3 had a comparatively broad nose. The lower jaw was found to protrude most in No. 1 and No. 3, and little or not at all in the smaller eels which I examined. The young eels caught near Limhamn had an unusually broad nose, especially the largest one. The color of the belly was a lively yellowish green. The stomach and intestinal canal of the larger eel which I examined were full of remnants of small crustaceans. Young eels are often caught in considerable numbers in the fish-pots used for catching various crustaceans. The quantity of the spawn bears a certain relation to the size of the fish, and on close examination can be discerned with the naked eye. The ovaries did not, however, entirely fill the abdominal cavity, and were probably far from being fully matured. The roe in the fish which I examined was generally larger than what Rathke found in full-grown female eels. Sundevall states that in September he found female eels containing roe, each grain of which measured $\frac{1}{5}$ millimeter, therefore resembling those which I had observed. In No. 1, examined by me, the breadth of the ovarium was 18 millimeters, and in No. 2, 12 millimeters.

Nevertheless, no "blank eels" are caught except late in summer and in autumn; and the stationary eels, the "grass eels," have never been noticed to migrate any distance. It has not yet been fully explained what relation exists between the stationary and the migratory eels. A Danish gentleman, T. Leth, who has given some attention to this subject, has in the *Fiskeritidende* advanced the opinion that the "blank eel" is nothing but the "grass eel" in its "wedding dress." He has in the Copenhagen fish-market examined a large number of eels and found many transition stages from the yellow-colored "grass eel" to the white or silver-gray "blank eel." Many circumstances favor Mr. Leth's opinion, and the difference of color among eels deserves to be studied more thoroughly, especially in our inland waters, where yellow eels are also found.

As has already been stated, the "grass eels" do not form the object of any considerable fisheries. They are caught principally with lines, and on the east coast sometimes in wicker fish-baskets. But these fisheries are very unimportant when compared with the autumn fisheries for migratory eels, when *hommor*, a sort of fish-baskets, are used.

The best season for the eel fisheries is late in summer and in autumn. The fishermen consider dark nights the best for eel fishing, because on moonlight nights the eels keep in the depths. On the east coast of Skane the fisheries begin in the middle or toward the end of August. The best fisheries are generally in September and October. In the Sound the eel fisheries begin toward the end of September, and the best fishing is generally in October. As soon as snow begins to fall and cold weather sets in, the eel fisheries come to an end.

The result of the Skane eel-fisheries during the three years 1879 to 1881, inclusive, was as follows:

Year.	Pounds.	Value.
1879	440, 634	$44, 284. 05
1880	232, 853	23, 248. 19
1881	147, 293	16, 073. 56

The most of the eels caught are sold fresh, and only a few are salted or smoked. The eels caught on the east coast of Skane are mainly bought up by German fish-dealers who have sailing vessels which from the central station of Kivik visit the neighboring stations and receive the eels before nightfall. The average price paid by these merchants is about $2 for 18½ pounds.

THE COD AND FLOUNDER FISHERIES.—The cod and also the plaice and other varieties of the flounder are found near the coast of Skane all the year round and form the object of fisheries, except during the season of the herring fisheries, when only old persons who can no longer engage in the herring fisheries continue to catch cod and flounders. The farther away one gets from the Cattegat and the Sound the less important do

these fisheries become, partly because the number of these fish is not as large, and partly owing to the greater distance from the great Copenhagen fish-market; for the greater portion of the cod and flounders caught on the coast of Skane are sold fresh, and it is simply for home consumption that any of these fish are salted or dried. Cod fisheries on a larger scale might pay even in the Baltic, where, at least during some years, the number of these fish is very considerable, and where a good article of cod in brine might be prepared.

Cod fishing goes on all the year round, unless prevented by ice. On the east coast of Skane, however, the more remunerative salmon fisheries (carried on with lines) have placed the cod fisheries in the background. The cod fisheries are exclusively carried on with lines, both on the coast of Skane and in the Sound, wherever a sufficient supply of suitable bait can be obtained. For bait are used a kind of snail (*Fusus* and *Buccinum*), crabs (*Palæmon squilla*), or, if these cannot be obtained, *Crangon vulgaris*. An excellent bait is *Arenicola piscatorum*, and also herring cut up. Near Raa the fishermen have transformed their boats into small vessels in which the cod are brought ashore alive. Here they are kept in a sort of fish-baskets until larger vessels come and take them to Copenhagen. Live codfish there sell for from 53 cents to $1.07 per 18½ pounds. Dead fish are sold by the score, and are of course cheaper. Of late years some codfish and flounders have during winter even been sent by railroad as far as Stockholm. In the Sound cod are caught both in shallow and deep water. Large codfish, weighing from 12 to 20 pounds, are caught, but seldom in the Sound. The codfish caught in the Sound generally weigh only about 37 pounds per score, and the larger kind about 54 pounds per score.

Of late years, since 1878, fishermen from Raa on the coast of Skane have begun to visit the waters near the small island of Anholt in the Cattegat. In the first year the number of vessels engaged in the flounder fisheries near Anholt was 4, which in 1881 had increased to 28. We possess no statistics regarding these Anholt fisheries except for the last-mentioned year, when the 28 vessels engaged in these fisheries had crews numbering 130 men and used 2,600 flounder-nets and caught fish to the value of $11,524. The flounders caught near Anholt are larger than those of the Sound and the coast of Skane, but their meat is coarser and does not have the delicate flavor of the small flounders. These Anholt fisheries begin in April and last till the middle of August, when people begin to get ready for the herring fisheries.

In the sound the cod and flounder fisheries commence as soon as the herring fisheries have come to a close in autumn, and continue, unless hindered by ice, through the entire winter. Three fishermen generally go shares in a boat, each with from 800 to 1,000 hooks. The fish caught are divided at the end of every week. The owner of the boat gets a separate share, and the remainder is equally divided among the fishermen. On the south coast of Skane there are always two men to each

boat, one owning the boat and the apparatus, while the other is his assistant and receives one-fourth of the quantity of fish caught. On the south and east coast of Skane *Zoarces viviparus* and *Ammodytes* are extensively used as bait in line-fishing. In the cod fisheries nets are not used as much as lines. These lines are as long as flounder lines. In the Sound they have generally 100 hooks each, and tufts 2 feet long at intervals of 4½ or 5 feet, thus making the length of the entire line from 75 to 80 fathoms. They have generally six floats and as many sinkers (stones) attached to lines 3 feet long. The line is thus kept at some distance from the bottom, which is an advantage. The flounder lines have neither floats nor sinkers, but rest on the bottom of the sea. The hooks are of brass. The codfish lines used on the east coast of Skane are 80 fathoms long and have 120 hooks, but no floats. They are generally set in the afternoon a few miles from the coast, and are hauled in the following morning. The same kind of lines are also used in the eel fisheries.

On the east coast the flounder fisheries do not begin till June. The best time for these fisheries, however, is in winter and spring, and for the cod fisheries in autumn and winter. It is said that both the cod and the different kinds of flounders stop spawning in March and April, but on the east coast of Skane the spawning season continues somewhat later.

THE SALMON FISHERIES.—These fisheries belong exclusively to the east and south coasts of Skane. In the Sound and on the west coast there are no salmon fisheries, although salmon are occasionally caught there with bottom-nets and codfish-nets. It therefore seems that the salmon do not migrate from the Baltic to the Cattegat and *vice versa*. Salmon are caught in the sea with seines, floating nets, and lines, each of these apparatus being peculiar to some part of the coast.

The floating-net fisheries begin early in spring, toward the end of March or in April, and continue till the end of May or the beginning of June. These nets are made of hemp, are about 20 fathoms long and 3 fathoms deep, the size of the meshes being 2.5 decimeters. They have cork floats but no sinkers, because even without these they are sufficiently heavy. Each boat has a crew of 3 men, and from 30 to 40 nets. One of these nets costs 10 crowns [$2.68].

The line fisheries begin in autumn after the herring fisheries have come to a close, and are continued throughout the winter, as long as the weather does not interfere with them. These lines (Fig. 18) are constructed so that they can float near the surface, and are fastened only at one end, while the other is free and is swayed by the current. That portion which holds the apparatus in its place is called the rope, and is fastened at the bottom by a large stone. Ater the stone has been sunk, about a fathom of the rope is hauled up, and a glass float is fastened to it. About 12 fathoms above this a second float is fastened, and about 5 fathoms below this the line is attached to the rope. It is

kept floating near the surface by four wood or cork floats. At present each line, measuring 30 fathoms, has only three hooks. These hooks, of tinned-iron wire, are tolerably large (8 centimeters long and with a span of about 4 centimeters), and are baited with herring, which are cut back of the anal aperture, and are fastened to the hook so that its point passes through the eyes and protrudes at the side. The salmon lines are set with a sufficiently large distance between them to prevent their becoming entangled when they are swayed to and fro by the current. The first glass float serves to keep the rope up in the water, and to prevent the current from carrying it too far from its original position. These lines are set at a depth of from 20 to 30 fathoms; the farther from the coast the better. As long as the water is still warm in autumn the hooks have to be baited afresh every day. When the water gets colder the herring keep three or four days without turning sour. If the bait is not entirely fresh, the salmon will not bite. In the autumn fisheries four men go out in a boat with from 40 to 60 salmon-lines.

During the stormy and dark season of the year these fisheries are both dangerous and uncertain, but pay well because the apparatus is cheap, as a line costs only from 3 to 5 crowns [80 cents to $1.34]. The success of these fisheries greatly depends upon the weather. The salmon also seem in some years to leave one part of the Baltic and go to another. On the south coast of Skane the method of catching salmon with lines has been almost entirely abandoned, because scarcely any were caught.

In some places on the south coast, during spring, salmon are caught with seines. These fisheries begin about the end of March or during the first week in April, and continue till the middle or end of May. These seines generally belong to the owners of the coast, who hire fishermen to carry on the fisheries, and give them in payment half the fish caught. Some of the seines, however, are owned by the fishermen. With these seines there were caught, especially in former times when there was no regulation as to the size of the meshes, a large number of small salmon, weighing between 2 and 3 pounds, sometimes even several boat loads. Since a regulation has been made that the meshes of the salmon seines must not be less than 2 inches, the small salmon are somewhat more protected. The length of these seines varies from 60 to 72 fathoms, and their depth is from 2 to 3 fathoms. They are drawn by two, three, or four men. Of late years the number of these seines has increased considerably, and this circumstance has doubtless contributed its share towards the decrease in the number of salmon which is complained of. In 1881 the salmon fisheries on the coast of Skane yielded an income of 18,478 crowns [$4,952.10]. The number of fishermen engaged in these fisheries in 1881 was 486, boats 125, seines 124, floating-nets 1,588, and lines 3,038.

OTHER SMALL FISHERIES.—Besides the fisheries mentioned above, there are fisheries on a limited scale for some other food-fish and marine

animals. Among these there are some kinds of fish which come from the Cattegat at certain seasons of the year and pass through the Sound into the Baltic. In some years these fish will come in considerable numbers, while in others their number is small or they stay away altogether. Among these we may mention the mackerel, the *Gadus æglifinus* L., and the hornfish (*Belone vulgaris*). Other fish are found near the coast of Skane all the time, but not in such quantities as to give rise to extensive fisheries. Among these there are several varieties of the flounder, the *Cyclopterus lumpus*, the *Ammodytes tobianus*, and the *Ammodytes lancea*.

The mackerel fisheries.—The mackerel make their appearance in schools about the end of May. On the coast of Skane mackerel fisheries are carried on along a limited stretch of coast in the northern part of the Sound, principally by fishermen from Hittarp and Raa. In the Sound proper these fisheries will pay only in exceptional cases, as when there has been a northerly current for several days. The mackerel nets are 60 fathoms long and 100 meshes deep; they are bound in two parts and are arranged something like the *närdingar* (see above), but have only 15 meshes to the yard. They are used both as stationary and as floating nets. In the mackerel fisheries each boat has a crew of three men and four nets. In 1881 the Skane mackerel-fisheries yielded an income of 1,010 crowns [$270.68]. During the last few years the number of mackerel has decreased very considerably.

The hornfish fisheries (*Belone vulgaris*).—These fish, like the mackerel, make their appearance in May and June, and are caught in bottom-nets in the Sound, and on the south coast of Skane in salmon seines. When the hornfish have been seen to go near the coast during the day the school is surrounded with a seine and the fish are driven towards it by throwing stones into the water. During the night hornfish are caught in seines in the same manner as salmon. There are no reliable data as to the income derived from these fisheries.

This may be the proper place to say a few words with regard to the bottom-nets, an apparatus which in Sweden is used only in a few places on the coast of Skane. The bottom-net consists of two parts—the so-called "land-arm," and the "head," or the place into which the fish are led and where they are caught (Fig. 19 A, B). The principle is the same as that of a common trap, but in the bottom-net there is a special bottom of net-work which is raised when the net is taken up. Bottom-nets are set even in very shallow water, and often stand in the water only up to a certain height. The deepest net of this kind, near Raa, stands about 2 fathoms in the water. Their dimensions are very considerable, their length being from 9 to 12 fathoms. The largest and most expensive are found in the Sound. It is a peculiarity of these nets that the poles which support the net are not driven into the ground, but are held in position by lines and grapnels. Bottom-nets are set as early as April and remain standing till the middle of July, when they are taken ashore to be set again in the middle of August, when they remain in

the water till the end of October. Every fourteenth day the nets are taken ashore and dried, while the poles and grapnels are left in the water.

Fisheries for Cyclopterus lumpus.—The male of these fish is by many considered a great delicacy, while the female is not esteemed so highly. These fish are caught in February, March, and April. They are said to spawn in the Sound in June and July. In the Sound this fish frequently reaches the length of 2½ feet.

Fisheries for Ammodytes.—These fish are caught both in the Sound and in the Baltic, and seem to have been more numerous in former times than now. They are caught in July and August with fine, small seines. They are eaten fried or dried, and have a good flavor. The quantity caught, however, is small, and these fisheries are of very slight importance.

Lobster fisheries.—Lobsters are found in small numbers on the coast of Skane. They are caught with fish-pots, and in the 120 to 128 fish-pots used in these fisheries 400 lobsters were caught in 1881.

Fisheries for other crustaceans.—Near the Kullen promontory a number of *Cancer pagurus* are caught every year, generally during the period from October to February. The boats used in these fisheries have a crew of three men each, and the apparatus used is generally old flounder-nets. These crustaceans sell near the Kullen promontory at from 25 to 33 ore [6 to 8 cents] apiece.

Of greater importance are the fisheries for *Palæmon squilla.* These small crustaceans are not only used as bait, but form likewise a very excellent article of food. They usually remain among the algæ, and are found principally in the southern part of the Sound, in the wide algæ bottoms near Saltholm, on the Danish coast, and near Malmö, Limhamn, and Holeviken, on the Swedish side of the Sound. The fishing season lasts from the end of April till the middle of September. These crustaceans wander along the coast; from May to August from south to north, and from August till the end of the fisheries from north to south. They are mainly taken in fish-pots, which vary in size, the rings varying from 1 to 4 feet in diameter. The apparatus consists of the fish-pot proper with two short arms, and a loose "land-arm" in the middle, 24 or 25 yards long, which is pushed by means of iron poles, four to each fish-pot. This apparatus is set in rows from the land, the opening turned towards the shore. Near Limhamn each boat has from 18 to 20 such fish-pots, costing from 20 to 25 crowns [$5.36 to $6.70] apiece, and in these fisheries each boat can earn from 500 to 600 crowns [$134 to $160.80]. It is only of late years that these fisheries have been carried on to any considerable extent. In former times only here and there a fisherman owned a few fish-pots, and kept very secret what he caught with them. Gradually, however, people began to find out that the income from these fisheries is important, and for the last 16 years they have been carried on very generally on the coast of Skane, and with such

success as to place the flounder fisheries in the background. The crustaceans caught are mostly sent to Copenhagen, where they fetch from 50 ore to 1 crown [13.4 cents to 26.8 cents] per *pot* (a *pot* = about 1 quart). Besides with fish-pots, these fisheries are also carried on with purse-nets attached to a pole (Fig. 21). The income derived from these fisheries in 1881 was 11,890 crowns [$3,186.52].

Statistics of the Skane fisheries.

Years.	Number of fishermen engaged in all the fisheries.	Income from all the fisheries.
1874	1,967	$170,052 96
1875	1,067	179,770 64
1876	1,039	189,452 41
1877	*2,216	228,753 00
1878	2,322	236,792 80
1879	2,602	215,571 96
1880	3,115	248,667 55
1881	2,938	254,408 91
Total		1,723,470 23

STATISTICS OF THE SWEDISH FISHERIES AND REMARKS ON THE IMPORTANCE OF SCIENTIFIC INVESTIGATIONS CONCERNING THEM.

There is no longer any doubt in the mind of any one that it is of great interest to have reliable data relative to the average annual yield which may be expected from our salt-water and fresh-water fisheries. It is generally acknowledged that statistics are of very great importance in forming a proper judgment of any industry in itself and in its relations to other industries, and the matter has of late years received considerable attention n Sweden, as far as the fisheries are concerned. In the Instructions to the Superintendent of Fisheries, issued February 12, 1864, he was enjoined "to prepare statistics of the fisheries considered as an industry in relation to the other occupations of the population, the capital invested, the income derived therefrom," &c. Thus far we have not been able to obtain statistics of our entire fisheries; and the same applies to every other country. Unfortunately we do not yet possess statistics embracing the more important fisheries of the entire Kingdom of Sweden; and in this respect Norway is ahead of us, as tolerably complete statistics of the Norwegian cod and herring fisheries are taken every year. In most other countries fishery statistics are still in their infancy, and the subject has not by any means been given the attention which it deserves. As a general rule people are satisfied with approximate figures based on rather uncertain calculations. Among the reasons therefor we must mention as the most important the difficulty in obtaining reliable data relative to the yield of the fisheries, a difficulty, however, which is often considered much greater than it really is.

The preparing of useful fishery statistics is connected with considerable trouble and expense, which might justly be considered as too great, if the question was merely to learn how many fish were caught and the economical significance of such numbers; but fishery statistics are also, from another point of view, of the greatest importance for the fishing industry. Like any other industry, the fisheries, if they are to be managed in a rational manner, must rest on a scientific basis. The first questions which have to be answered are the following: What circumstances determine the changes in the result of the fisheries? And which among these are caused by man, and which not? For this purpose it is in the first place necessary to know the yield of the fisheries, for without a knowledge of the fisheries and their yield it is impossible to draw any certain conclusions relative to the circumstances which influence the fisheries. Any one who is earnestly determined to answer the above questions will soon find that the statements of old fishermen cannot be relied upon, as has hitherto been the case in many instances. As soon as the question becomes one of science, one can no longer content himself with statements of fishermen, such as that the fisheries grow worse from year to year, or that such and such a wind brings good fisheries, &c. Observations are necessary, observations taken systematically for a considerable length of time and taken in different localities; in short, the course of the fisheries must be made the subject of scientific investigations. I shall below give an instance to show how easy it is to draw hasty conclusions from a knowledge of fisheries limited to a few years. The importance of investigating the fisheries themselves has, in my opinion, always been too much overlooked, while we are often told of the vast importance of the investigation of various circumstances which have an influence on the fisheries, such as the flora and fauna of the water, its saltness, temperature, &c. Such investigations are doubtless important, but only by combining them with data relative to the fisheries themselves do they become of practical value, as otherwise they easily lead to erroneous hypotheses of doubtful value, instances of which are but too frequent in the history of the fisheries. A knowledge of the course of the fisheries for any considerable period of time cannot be obtained without statistical data, and this goes to show that statistics are the true basis of a thorough investigation of the fisheries.

Fishery statistics are of considerable value, even if they relate only to a certain fishery or a single locality, as showing the course of the fisheries; especially if they are accompanied by data relative to various circumstances which have exercised an influence on the fisheries. The more detailed and extensive the statistics are, the greater will be their value. But outside of the interest which fishery statistics possess, as furnishing the material for a scientific solution of the various problems connected with the fisheries, they are of great practical value to the owners of fishing waters, for judging whether the quantity of fish will be influenced by the extent to which fishing is carried on, for calculat-

ing the average yield of fisheries and their actual value, for ascertaining the indemnity to be paid for any damage done to the fishing waters, and such matters.

It is exceedingly important to be able to decide whether an increase or decrease in the yield of fisheries is to be considered as a continual increase or decrease in the quantity of fish, or is simply caused by the changes to which all fisheries seem to be subject; and, if so, if any periodicity in the course of the fisheries can be observed. In certain cases it will be easy to show unmistakable causes of a decrease in fisheries, but in most cases this will be exceedingly difficult, and even impossible, without statistical data. As an exceedingly interesting example of the changes to which fisheries are subject, I give below a table showing the quantity of salmon caught in a *laxpata* (a sort of salmon-trap) at Svartö, on the Luleå River. The *laxpata* is a contrivance consisting of piles and nets, where the salmon enters and is taken out with special nets. These traps are set in the rivers in spring as soon as the depth of the water will allow it. The Svartö fishing station is near the mouth of the Luleå River, and is therefore not influenced by fisheries further down the stream.

Table showing the fishing season, and the quantity of salmon caught at the Svartö fishing station during the period 1804 *to* 1880.

Year.	Fishing season.	Number of salmon caught.	Weight in *lispund*.*	Year.	Fishing season.	Number of salmon caught.	Weight in *lispund*.
1804	June 20 to Aug. 13	904	1,125	1843	...	...	2,816
1805	June 28 to Aug. 13	721	901	1844	...	...	1,452
1806	June 28 to Aug. 11	792	990	1845	...	...	1,232
1807	July 1 to Aug. 11	1,103	1,379	1846	...	...	440
1808	June 29 to July 24	1,878	2,348	1847	...	...	1,452
1809	June 24 to Aug. 3	1,842	2,202	1848	June 16 to Aug. 10	...	392
1810	July 4 to Aug. 8	1,186	1,483	1849	June 21 to Aug. 7	...	1,308
1811	June 27 to Aug. 4	1,544	1,930	1850	June 18 to Aug. 15	...	572
1812	June 26 to Aug. 7	1,000	1,250	1851	June 25 to Aug. 8	...	1,056
1813	June 24 to Aug. 4	632	790	1852	June 17 to Aug. 10	...	880
1814	June 27 to Aug. 6	827	1,034	1853	June 16 to Aug. 4	...	616
1815	June 27 to July 31	405	506	1854	June 18 to July 24	...	1,760
1816	June 23 to Aug. 4	658	823	1855	June 23 to Aug. 1	...	352
1817	June 22 to Aug. 11	1,551	1,939	1856	June 16 to Aug. 10	...	2,288
1818	June 22 to July 29	922	1,153	1857	June 24 to Aug. 14	...	1,012
1819	June 24 to July 27	1,221	1,526	1858	June 13 to Aug. 6	...	1,056
1820	June 22 to July 29	993	1,241	1859	June 15 to Aug. 3	...	1,056
1821	June 21 to Aug. 7	1,390	1,738	1860	June 12 to Aug. 3	...	1,672
1822	June 18 to Aug. 8	1,738	2,273	1861	...	...	3,520
1823	June 27 to Aug. 11	1,734	2,168	1862	...	...	1,584
1824	June 17 to Aug. 4	1,610	2,013	1863	...	...	1,232
1825	June 21 to Aug. 14	1,112	1,390	1864	...	...	704
1826	June 9 to Aug. 4	5,350	6,688	1865	...	...	704
1827	June 20 to Aug. 7	3,251	3,064	1866	...	...	880
1828	June 20 to Aug. 12	1,332	1,665	1867	...	...	176
1829	June 24 to Aug. 14	971	1,214	1868	...	...	704
1830	June 28 to Aug. 13	1,478	1,848	1869	...	...	616
1831	June 17 to Aug. 8	719	899	1870	...	...	352
1832	June 12 to Aug. 3	1,280	1,590	1871	...	...	880
1833	June 17 to Aug. 13	828	1,034	1872	...	...	528
1834	June 16 to Aug. 4	1,338	1,662	1873	...	...	672
1835	...	...	2,816	1874	June 18 to Aug. 21	...	2,562
1836	...	...	2,288	1875	June 15 to Aug. 18	...	1,793
1837	...	...	528	1876	June 23 to Aug. 28	...	3,385
1838	...	...	880	1877	...	...	1,896
1839	...	...	176	1878	June 13 to Aug. 9	...	1,025
1840	...	...	396	1879	...	...	218
1841	...	...	1,100	1880	...	...	1,076
1842	...	...	1,276				

* 1 *lispund* equals about 18.6 pounds.

These fisheries are owned by several persons, and for this reason it became necessary to keep a record of the fish caught, so that they could be equally divided. These data are therefore perfectly reliable. The manner of keeping the records differed somewhat at different times, the number of salmon being given at one time, and the weight of the fish at another.

From these statistics it appears, first, that the salmon fisheries then as now were subject to considerable changes. Calculated in pounds, the quantity of salmon caught during the 76 years when these records were kept amounted to 1,845,230 pounds, or an average of 24,275 pounds per annum. Calculated by five-year periods we get the following result:

Period.	*Lispund.*	Period.	*Lispund.*	Period.	*Lispund.*
1804–8	1,349	1829–33	1,317	1854–58	1,294
1809–13	1,531	1834–38	1,635	1859–63	1,813
1814–18	1,091	1839–43	1,153	1864–68	634
1819–23	1,789	1844–48	994	1869–73	610
1824–28	2,964	1849–53	886	1874–78	2,132

During 33 years the number of fish caught has come up to or exceeded the annual average of 1,305 *lispund* [24,275 pounds], and during 43 years it has fallen below that average. The richest fisheries occurred during the period from 1820 to 1830, especially during the period from 1824 to 1828, when the average per annum rose to 2,964 *lispund*, and the richest fisheries during that period were in 1826, when 6,688 *lispund* of salmon were caught; the poorest fisheries were in 1839 and 1867, when only 176 *lispund* of salmon were caught. From about the year 1835 there were a number of poor fishing years, which were followed by a number of good years after 1840; but from 1850 to 1855 the fisheries again became poor. The same was the case to a still greater degree during the periods 1864–1868 and 1869–1873, while during the following five-year period the fisheries increased again.

It will therefore be seen how difficult it is to judge from a few years' data whether the fisheries are continually declining, and that even poor fisheries, continued for several years, are not in themselves sufficient (without showing any specific cause for the same) to prove that such is the case. The above data do not, in my opinion, prove any periodicity in these fisheries. As regards the season when the fisheries began and during which they were carried on, it appears from the above data that during the first decades the fisheries began somewhat later in June than was the case more recently. The time when the fisheries began does not, as a general rule, seem to have exercised any influence on the quantity of fish caught. It should be observed, however, that during the richest salmon year, 1826, the fisheries commenced unusually early, on June 9, while in the particularly unfavorable year, 1867, the ice in the Luleå River did not begin to break till June 1, which of course

made the beginning of the fisheries rather late. In the year 1810, when the fisheries did not begin till July 1, the number of fish nevertheless exceeded the average.

The data relative to the Svartö fisheries are certainly not extensive enough to enable us to answer the question as to the causes why the fisheries resulted as they did, but it must be acknowledged that they furnish valuable contributions toward answering, among other things, various questions relating to the number of fish in former years and now.

Common people frequently distrust statistics, not the least those relating to the fisheries, because it is known that it is impossible to obtain absolutely exact data, partly for the reason that the fishermen themselves do not know exactly how many fish have been caught. It is of course desirable to get as accurate statistics as possible, but on the other hand it is not necessary to know the yield of the fisheries down to the pound; nor do statistics from one locality lose all their value because they are not complete in every respect, or because they are incorrect in some of the minor details. Small mistakes and imperfections are eliminated where general results are obtained, and the figures will nevertheless give a tolerably correct idea of the actual condition of things. Experience has shown that the disinclination of the fishermen to furnish statistics has soon disappeared when they found that no evil consequences resulted therefrom. In order not to mislead, the statistical data should enter sufficiently into detail, and should explain themselves as far as possible.

Fishery statistics, however, cannot by themselves solve the problems which require solution, if the fisheries are to be carried on in a rational manner. There should be considered the methods employed in the fisheries, the condition of the weather, and other circumstances which are supposed to have an influence on the fisheries.

It has long been acknowledged that it is of great importance to investigate the physical condition of the sea, its temperature, saltness, &c. On the German coasts stations were established ten years ago, not only for examining the physical condition of the waters of the Baltic, but also to take a record of the yield of the fisheries at said stations. In Sweden we have now a Nautico-meteorological Bureau, whose observations, it is true, embrace only hydrography, and not, like the German stations, the fisheries and their yield. But many of the stations of this Bureau, because they are located on the fishing grounds, become of great importance to the fisheries.

But in order that such investigations may be of real value to the fisheries, it is necessary that they should go hand in hand with observations relative to the course of the fisheries. I have, therefore, with the limited means at my disposal, endeavored to work in this direction, and have had a station established at Hufvudskör, on the coast of Stockholm, where observations are taken regarding the saltness and

temperature of the water, near the surface and also at a depth of ten fathoms. I have also caused the superintendents at some of the Skane fishing stations to keep a journal of the temperature of the water near the surface, and a record of the wind, current, and the daily yield of the fisheries; but I have not asked them to give the exact number of fish caught every day, because this would involve considerable trouble, and hardly seems necessary. Even for obtaining a correct idea of the course of the salmon fisheries and of the circumstances which influence them, such observations are of great interest. On some of our salmon streams the superintendents of the fisheries, or special observers, have taken observations relative to the depth of water in the stream, its temperature, and such matters.

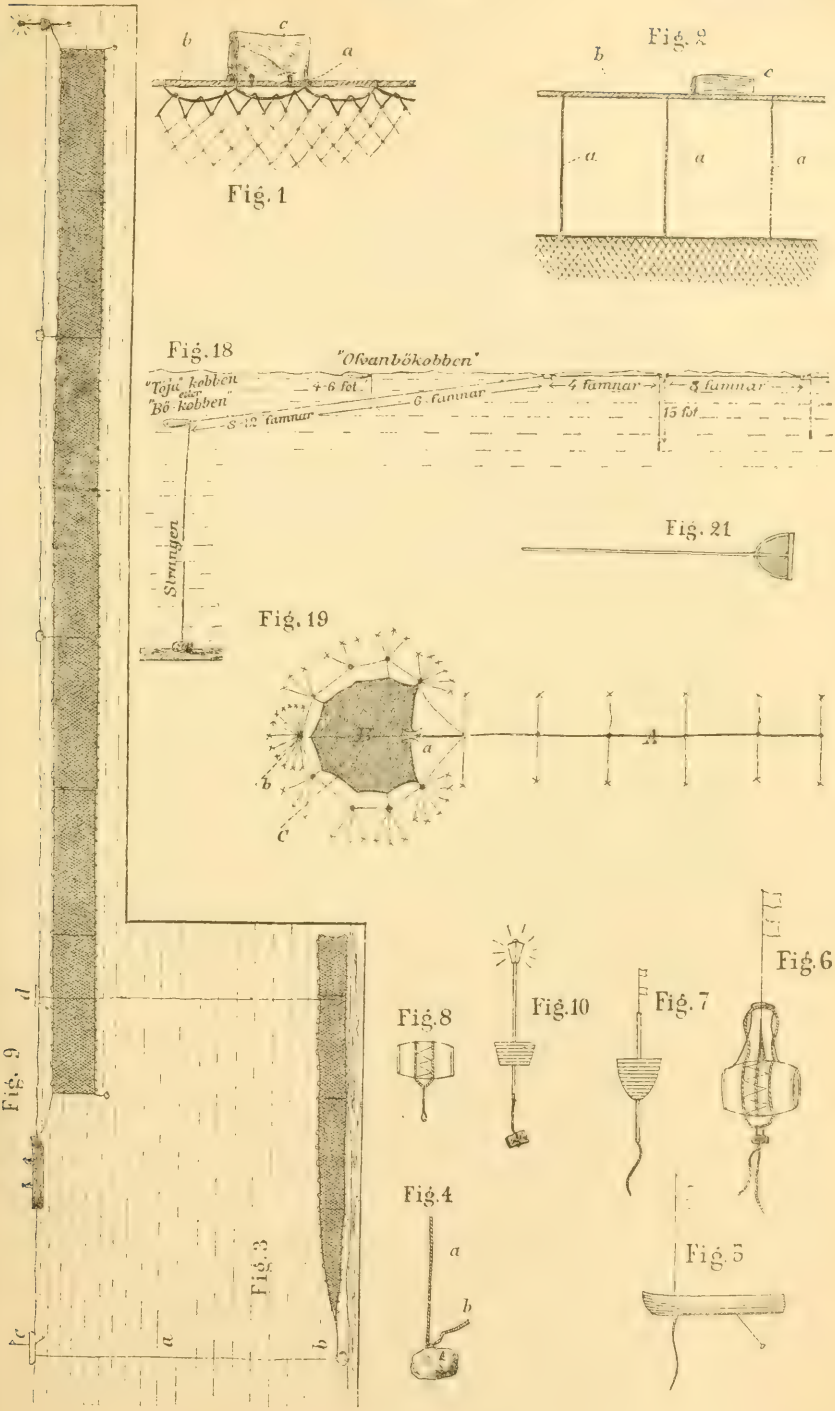
Fig. 1
Fig. 2
Fig. 18
"Ofvanbökobben"
"Töju" kobben eller "Bö-kobben"
4-6 fot
6 famnar
8-12 famnar
4 famnar
8 famnar
15 fot
Strängen
Fig. 21
Fig. 19
Fig. 9
Fig. 3
Fig. 8
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Fig. 5

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XXVIII.—THE FUTURE OF THE HERRING FISHERIES ON THE COAST OF BOHUSLAN.*

By Axel Vilhelm Ljungman.

As it is well known that the different Bohuslän herring periods resemble each other, in that they show regular changes in the course of the fisheries, caused by a change of the locality where the herring approach the coast and by a change of time when this takes place, and as, therefore, it is possible to judge with some degree of certainty, from the course of the fisheries during a preceding period, how the course will be during a coming period, I will endeavor to give some such prognostications. Unfortunately, we possess no exact and full data as regards the close of any of the former herring periods, but those which we have from the last century are sufficient to serve as a guide. In a report on the herring fisheries in 1758 we read, relative to the place where the fisheries were carried on, the following: "In 1747 and 1748 a large number of herring began to approach the northern portion of the coast of Bohuslän; later they went farther south, as far as Marstrand, and in 1752 they made their appearance near Gothenburg;" and in a report dated April 22, 1761, it is stated that "from the year 1759 (?) the herring were principally found on the southern portion of the coast of Bohuslän, between Gothenburg and Marstrand, and about 3 or 4 miles north of the last-mentioned town." From a report for 1764 it appears that "in autumn the herring were principally found on both sides of the island of Marstrand, and some years in great quantities near the Gothenburg coast, and even as far south as the coast of the province of Halland;" but that "in autumn and towards winter they went farther north, as far as the Gullmars fiord, and occasionally up to the Norwegian boundary line."

From a pamphlet published in 1765, and entitled "The necessity for appointing a director of fisheries in the districts of Bohus and Gothenburg," it appears that the principal place of sojourn of the herring was the central and southern portion of the coast of Bohuslän, which is also confirmed by the so-called "Oil-refuse Act" and numerous other reports. If we compare these data with those gathered during the pres-

* "*Det förestående sillfisket i Bohuslänska skärgarden.*" Gothenburg, 1883. Translated from the Swedish by Herman Jacobson.

ent herring period, it will be found that during the winter of 1877–'78 the herring fisheries commenced in the northern portion of the coast of Bohuslän (principally in the neighborhood of Norrviken); and that during the winter of 1881–'82 they went as far south as Marstrand, and during last winter (1882–'83) as far south as the northern portion of the Gothenburg coast; and, therefore, it is to be expected that during the approaching fisheries the herring will in still larger number visit the last-mentioned coast, although probably they will not, as in 1752, enter the canals of the Gothenburg Harbor and be caught as far inland as Tingstad. There is, therefore, reasonable hope that the herring, during the approaching portion of the herring period, will be found principally on the central and southern coast, and that later during the period they will again show a decided preference for the coast north of Marstrand. Towards the end of the year, and about the beginning of the new year, however, it is probable that the northern part of the coast will also be visited by herring.

As regards the time of the year when the herring begin to approach the coast in considerable numbers, it appears that during the first fifteen years of a herring period they came a little earlier every year, and that after the fifteenth year they gradually came later and later. According to the "Oil-refuse Act," the fisheries, which during the first part of the period were carried on with nets, began as follows:

Year.	Day of beginning.	Year.	Day of beginning.	Year.	Day of beginning.
1753	Sept. 29	1764	Sept. 7	1775	Not given.
1754	Sept. 16	1765	Sept. 10	1776	Not given.
1755	Sept. 11	1766	Sept. 9	1777	Not given.
1756	Sept. 22	1767	Sept. 25	1778	Nov. 4
1757	Sept. 3	1768	Oct. 5	1779	Oct. 24
1758	Sept. 9	1769	Oct. 3	1780	Not given.
1759	Aug. 23	1770	Oct. 4	1781	Oct. 24
1760	Aug. 20	1771	Oct. 17	1782	Not given.
1761	Sept. 8	1772	Oct. 14	1783	Nov. 4
1762	Aug. 16	1773	Oct. 14		
1763	Aug. 29	1774	Not given.		

For the first six years of the period we have no exact data, but probably in the beginning of a period the fisheries have always been somewhat uncertain, and have gradually begun earlier from year to year. During the present period rich fisheries on the coast began in 1877 during the first half of December, in 1878 and 1879 about Christmas, in 1880 in the beginning of December, in 1881 about the middle of November, and in 1882 in the beginning of November (the herring having already begun to approach the coast towards the end of October). If the course of the fisheries is nearly the same during the present as during the last period, it may be expected that during the coming autumn (1883) they will begin in October, possibly towards the end of September, and that during the period from 1889 to 1893 they will approach the coast in August, and after that time in September, and continue to come about that time till the year 1897 or 1898, when they

will gradually come later and later. From the above data it appears, however, that the approach of the herring to the coast does by no means take place regularly at the exact time at which it was expected, but that there are exceptions, amounting to two and sometimes to three weeks, probably caused by irregularities in the state of the weather. As long as meteorology and hydrology are in their present undeveloped condition, it is impossible to give an absolutely correct explanation of these irregularities in the course of the fisheries, or to give any reliable hints to the fishermen. Some light, however, might be thrown on the subject by judicious experiments; and it is therefore much to be regretted that what has been done in this direction by Superintendents Smitt and Von Yhlen has been done in such an utterly unsystematic way as to yield no satisfactory results. It is necessary for the fishermen to make their calculations beforehand, and so long as no reliable scientific data were furnished they had to be satisfied with the historical data as a basis for such calculations.

The exceptional condition of the weather during last summer, and the very unexpected course of the herring fisheries on the east coast of Scotland (the northeasterly portion of the coast having the richest fisheries, while during the preceding ten years this condition of affairs was entirely reversed), have doubtless tended to increase the uncertainty regarding this year's fisheries, more especially as we have no data from former periods to guide us in this matter. We hope for the best and look for early and rich fisheries.

Further on in the herring period, when the herring approach the coast as early as August and the first half of September and spawn there, it may be expected (to judge from the experience of the last century) that a larger number of so-called *inmat* herring will be caught on the inner coast than are now caught with floating nets on the outer coast. These *inmat* herring, which spawn in autumn, must not be confounded with the somewhat larger herring which spawn towards the end of winter or the beginning of spring, and which are caught much later in autumn and in winter, principally on the northern coast of Bohuslän, where they might form the object of much more extensive fisheries than is the case at the present time, if the purse-seine was more generally introduced.

As regards the undoubted influence of the weather on the course of the fisheries and on their yield, the proposition has been made to introduce floating-nets, with the view to carrying on the fisheries advantageously and on a large scale during a larger portion of the year than hitherto, and without being influenced by the condition of the weather, as is the case now when our common herring nets are used. There is a good deal of truth in this, as during autumn the weather is often such as to cause the fisheries to begin later than had been expected, and to enable the fishermen to catch herring with floating-nets some distance from the coast, as was done in the beginning of last autumn. The state

of the weather can, therefore, be of such a kind that fisheries with floating-nets may commence several weeks sooner than the fisheries near the coast; but strong west winds may prevent floating-net fisheries of any importance from taking place before the fisheries begin near the coast. This uncertainty, which during the approaching portion of the herring period, when the herring will come to the coast a little earlier every year, will make itself particularly felt, will certainly render futile all attempts to induce the Bohuslän fishermen to adopt Professor Smitt's proposition to exchange the common nets for floating-nets. Floating-nets certainly yield a much larger percentage of large herring than our common herring nets; but this advantage is considerably diminished during that portion of the herring period when the herring, independent of the condition of the weather, approach the coast for the purpose of spawning, and when the fisheries carried on with our common herring nets yield a large percentage of so-called *maties* herring. It has been said that floating-nets would not catch the spent herring nor the smaller so-called "medium herring," but the experience of Scotland utterly disproves this assertion; and it may be said that the floating-net is the apparatus best adapted to catch the spent herring, which, as is well known, can not be caught with our common herring nets.

As regards the percentage of *inmat* herring which may reasonably be expected from the floating-net fisheries conducted on a large scale off the coast of Bohuslän, we may state, by way of illustration and in order to give some basis for an estimate, that in Fraserburgh, the principal fishing station in Scotland, the following number of barrels were stamped with the crown stamp during the year 1881: 54,498½ "fulls," 43,048 "maties," and 15,910 "spents," or considerably more than half of the number of herring of the lower grades, which number, of course, would have been larger if the herring which were not stamped could have been taken into account. There is no reason to suppose that there should be on the coast of Bohuslän more "maties" than on the east coast of Scotland, particularly as the fisheries on the inner coast of Bohuslän show that the number of so-called "medium" herring and of large "spents" is enormous. These fish come from the sea and enter the fiords, and they certainly might be caught with floating-nets on a large scale in the Skager Rack just as well as on the east coast of Scotland. Fishermen using floating-nets should here, as in Scotland, be glad to catch these small herring, which make the fisheries more profitable. The character of the fish caught during the same season varies very considerably; one boat will catch only "maties" and another so-called "medium" herring or "spents." According to the Fish Trades Gazette, No. 5, p. 99, the average prices of these different kinds of herring, when bearing the stamp, on the east coast of Scotland, are as follows: "Fulls," 34 shillings; "maties," 24 shillings; and "spents," 25 shillings. A barrel of salt "fulls" has, therefore, less value than 2 barrels of the lower grades. For smoking or for use while fresh the *inmat*

herring offer far less advantages, as compared with the lower grades, than for salting. Whether we shall ever have floating-net fisheries on a large scale will depend on the yield as compared with the expenditure for buying and keeping the apparatus, the labor required, and the general advantages to the fishermen. They will, of course, choose the apparatus which in every respect offers them the greatest advantages.

In judging this question, which is of the utmost importance for the development of the Bohuslän coast fisheries, we should have due regard to the vast difference between fisheries on a large scale, whose yield is to a great extent prepared for exportation, and small fisheries, whose yield is principally consumed, either fresh or slightly smoked, near the fishing stations. It is an erroneous idea that a fishing apparatus or a method of fishing can be introduced with us to any advantage simply because one could obtain necessarily high prices for small quantities of herring sold in Gothenburg by the score at a time of the year when very few fresh herring are brought into the market. It would also be a mistake to draw comparisons between the price of herring, based on their actual value, when brought into the market in large quantities, and the fancy prices paid for herring when they are scarce, prices which are paid without any regard to the apparatus or method of fishing employed. It should also be remembered that because a certain way of earning a living is profitable in one locality it need not be the same in another where the natural conditions, the character of the population, and the facilities for selling are entirely different. Before introducing a new method of earning a living it should be ascertained whether all the necessary conditions of success are either found in the locality in question or can be furnished. Otherwise the mistakes of former times would only be repeated, and the means already possessed by the people, which with proper and careful use might yield good results, would be uselessly squandered. This has been the experience in Scotland and Bohuslän during the last century.

As attempts made during the last herring period to inaugurate fisheries on a large scale with floating nets on the Dutch plan proved failures, the royal fishery commission in 1770 [1870?] proposed that an attempt should be made to have floating-net fisheries on a small scale and with cheap apparatus. The same proposition was made somewhat later by Rev. Mr. Ekström, but without success. This proposition to use seines on the mackerel boats for catching a small quantity of herring during the light season of the year was again made by the author in 1880, as a desirable and comparatively harmless experiment; but this proposition is entirely different from the one made by Professor Smitt to carry on the Bohuslän herring-fisheries exclusively with floating-nets, as on the east coast of Scotland, instead of with seines, which, strange to say, he thinks should be entirely prohibited. The floating-net fisheries will prove undesirable only when they, like the fixed nets on the west coast of Nor-

way, shall be used to such an extent as to prevent the use of the more advantageous net called the purse-seine (*snörpvad*).

We shall now have to inquire what are the prospects of introducing floating-net fisheries on a large scale, and what would be the effect of their introduction on the coast of Bohuslän. With the view to answering this question we shall have to make a brief statement showing the relative cost of the different apparatus, the amount of labor required, and the relative yield, and in doing this we will institute a comparison between the floating-net fisheries on the east coast of Scotland and the Bohuslän seine fisheries.

The floating nets employed in the Scotch herring-fisheries represent a value of about 12,000,000 crowns [$3,216,000], one-third of which sum must be counted every year for the wear and tear of these nets, while a number of seines with which fully as many herring might be caught would cost only about 1,000,000 crowns [$268,000]. The value of the nets and boats employed in the Scotch herring-fisheries is more than 20,000,000 crowns [$5,360,000], and the number of fishermen engaged in these fisheries is about 40,000; while on the coast of Bohuslän, during the best portion of the last herring period, scarcely 6,000 fishermen, with nets and boats whose value (according to modern prices) would be only about 1,250,000 crowns [$335,000], during a small portion of the year would catch a larger quantity of herring than has ever been caught in Scotland during the longer portion of the year when the Scotch herring-fisheries are going on. The maximum annual yield of the Bohuslän fisheries during the last herring period was about 2,000,000 barrels (1 barrel = 1.65 hectoliters and contains almost 44 gallons) of herring, while in Scotland the maximum annual yield has never exceeded 1,750,000 barrels. The sums expended in buying and keeping in repair the material of the Scotch floating-net fisheries are so enormous that the Bohuslän fishermen could never succeed, even during an entire herring period, in raising them. With the means at their command they could get only a small quantity of floating-nets, and the slight increase in the yield of the fisheries resulting therefrom would hardly justify the change. The question of expense, therefore, principally stands in the way of a change from our nets to the Scotch floating-nets. A first-class Scotch floating-net boat, fully equipped, costs (see British Fisheries Directory, p. 193) more than 9,000 crowns [$2,412], or at least as much as three sets of Bohuslän nets and boats. A Scotch floating-net boat requires a crew of 6 or 8 men, while an entire set of Bohuslän boats only requires from 12 to 16 men.

It would be a mistake to think that floating-net fisheries could be successfully managed on a large scale on the coast of Bohuslän with a smaller number of floating-nets, fewer boats, and fewer men than on the east coast of Scotland. If floating-net fisheries on a large scale are to pay, they must be carried on with sufficient material and with a sufficient number of men. Three men will never be able to haul in a set of

Scotch floating-nets filled with herring, and any one making such an assertion simply shows his entire ignorance of these fisheries. The large Dutch and English floating-net boats generally have a larger crew (the boats used in the great Dutch fisheries have 14 or 15, and the Yarmouth boats have from 9 to 12 men), but, in spite of the greater number of men they often find it very difficult, especially in bad weather, or when the catch is unusually large, to haul in the floating-nets.

The average quantity of herring caught by the boats engaged in the fisheries on the east coast of Scotland during the exceptionally favorable year 1882 was as follows:

Locality.	Boats.	Barrels per boat.	Locality.	Boats.	Barrels per boat.
At Wick	600	116½	At Fraserburgh	900	155
At Lybster	157	11	At Peterhead	822	151
At Helmsdale	160	24½	At Aberdeen	482	166½
At Buckie	62	73½	At Montrose	166	173½
At Macduff	66	148	At Eyemouth	381	157

At most of the smaller fishing stations, not given in the above statement, the average quantity of herring caught was less that 100 barrels. In average years or in unfavorable years the figures are of course much lower than those given above; but even at best they are too low to induce a Bohuslän fisherman to make a change to the Scotch method. The reason why the Scotch fishermen can continue their fisheries even after such a small yield as in 1882 at Lybster is that they make a good living either by catching herring at other seasons of the year in other localities than the east coast of Scotland, or by engaging in other fisheries. If we look at the difference in the quantity of fish caught by boats belonging to the same fishing station, we shall find that it is still greater than the difference in the quantities caught at the different stations, for floating-net fisheries in great measure resemble a game of chance.

If we now compare, on the basis of the above data, the Scotch floating-net fisheries and our seine fisheries, as regards their economical advantage, we shall find that for catching a certain quantity of herring with floating-nets near the Scotch coast there are needed at least seven times as many men and an apparatus costing eighteen times as much as is needed on the coast of Bohuslän for catching the same quantity of herring. This also explains why the Bohuslän herring-fisheries did not amount to much during the herring period of the seventeenth century, for during that period the fisheries were exclusively carried on with large nets resembling the seines, which required a very large number of fishermen but which yielded only a small quantity of fish. Only with the seines employed in Bohuslän at the present time is it possible to make big catches with a small number of fishermen and cheap apparatus. If in making this comparison we also take into account the difference in

the total value of the fish caught, and the different percentage of "full" herring among them, our nets will be found far superior; for, as has been said above, the difference in the character of the fish caught is not by any means sufficiently great to correspond to the difference between the quantity of the fish and the cost of the material. If the sale of fish was better arranged, the Bohuslän fishermen, with their cheap material, would derive greater profits from their fisheries than the Scotch do from theirs.

The expensive material, the uncertain and occasionally very small yield, the greater risk of losing both material and life, the short fishing season on the coast of Bohuslän, and the unfavorable natural conditions (such as the great depth of the water and the prevailing land winds), and, finally, the strong competition with the common herring-nets and the so-called *snörpvader* (purse-seines), will always prevent the introduction on a large scale of apparatus and methods like the Scotch. A fisherman will hardly content himself with smaller yields, a smaller income, and fewer chances to gain a competency simply to prove the truth of Professor Smitt's assertion that the more uncertain and less productive method of fishing would be more advantageous in the distant future. It should likewise be remembered that the Bohuslän fishermen are, as a general rule, not like the fishermen of Great Britain and the Netherlands, practiced in the herring fisheries from their earliest youth, but that, on the contrary, they become herring fishermen merely to earn some money during a short portion of the year, after which they return to their proper vocations as soon as the herring fisheries are over. This is a necessary consequence of the secular periodicity of the Bohuslän herring-fisheries, and it is impossible to make a change in this respect. The inconveniences attending the fisheries are numerous enough, even if the coast population does not, as Professor Smitt proposes, leave its principal pursuit, agriculture, as early as the middle of August, in order to engage in large floating-net fisheries on the Scotch plan. Any one who will impartially examine our circumstances will find that our population acts wisely in first giving attention to its principal pursuit, and after that has been done (late in autumn) in engaging in the herring fisheries, and employing a method and apparatus which promises a better income than the expensive apparatus proposed by Professor Smitt.

As regards the often-repeated assertion that large permanent coast fisheries like the Scotch could be established in the eastern portion of Skager Rack by fishing with floating-nets instead of with seines, both experience and science have completely refuted it, and have proved that the sea-herring visit the coast of Bohuslän at secular periods, and that peculiar natural conditions, differing very much from those found in the North Sea, render it utterly impossible permanently to establish such rich coast fisheries in the Eastern Skager Rack.

If we consider the experience from the Bohuslän herring period of the

seventeenth century, and the data given above relative to the equipment and labor needed for the two methods under discussion and their respective results, we shall soon find that those persons who have proposed that the Bohuslän herring fisheries should be conducted on a large scale, with floating-nets instead of with seines, can hardly have understood the full bearing of their proposition, for it is so utterly unreasonable that no thoughtful person, acquainted with the circumstances of the case, could ever have made it.

As it is desirable, however, that the Bohuslän herring-fisheries should be still further developed by the introduction of other apparatus than our common herring-seines, it has, for very good reasons, been proposed to introduce as generally as possible the American purse-seine (*snörpvad*) as the first step most suitable toward the improvement of our fisheries. This excellent apparatus can be used with equal advantage near the coast and at a distance from it, and for catching different kinds of fish which go in schools (such as mackerel, herring, and cod); while our nets will catch only fish having a size corresponding to the size of the meshes.

The purse-seine, which possesses all the good qualities of the other seines, has this additional advantage, that, as it can be used without a landing place, there is no danger of infringing upon the rights of the owners of the coast or of interfering with other nets. It, moreover, insures more certain and better catches, as the valuable *inmat* herring cannot, as a general rule, be caught to any great extent with our common seines. The assertions that the purse-seine could only be used when the fish are near the surface of the water, and that the quality of the herring caught in it could never be as fine as of those caught in a floating-net, are entirely erroneous, and are mere inventions of the zealous defenders of the floating-net. The purse-seine, used at the same time and in the same locality as a floating-net, will catch exactly the same kind of fish, but in a less damaged condition. As regards the rumors spread on the coast of Bohuslän that the use of the purse-seine is to be prohibited, we may state authoritatively that there is no foundation at all for them.

The question of introducing this excellent apparatus has been raised also in Scotland, and at the suggestion of Mr. Birkbeck, M. P., an American fishing schooner is to be hired to sail along the coast of Scotland and instruct the fishermen in the use of the purse-seine. This is done in a country whose fishing industry is acknowledged to be the most advanced of any country. In Sweden, however, a professor of the Academy of Sciences is commissioned to write a treatise recommending the use of the floating-net and condemning the purse-seine, which treatise, based on erroneous information and defective knowledge of the subject, is published in the official journal of the kingdom and thence has made its way through our entire press.

The purse-seine was introduced into Europe by Mr. Andersen, of Aalesund, Norway, the Norwegian commissioner at the Philadelphia Ex-

hibition of 1876, and by Mr. Wallem, a newspaper editor of Bergen. From Norway the purse-seine was brought to Bohuslän, where several newspaper articles directed public attention to it, and caused several persons to order this apparatus, which soon, owing to the good results obtained with it, found more general favor. In the last official report on the Bohuslän sea-fisheries the following is said regarding this new apparatus:

"Purse-seine No. 1, from Öckerö, has caught fish to the value of 29,000 crowns [$7,772], and the three other purse-seines which were received here in autumn caught fish to the value of 16,000, 6,000, and 3,500 crowns [$4,288, $1,608, and $938], respectively. In consequence twenty more of these purse-seines have been ordered, some by the Fishery Association and some by private individuals."

If we take into consideration the circumstance that the above-mentioned large sums were received for fish sold by the boat-load, which under other conditions of sale might have brought a much higher price, and that our fishermen have had but little experience in the use of this apparatus, there ought to be no longer any doubt that the purse-seine is far more profitable than any other apparatus used in the herring fisheries. The object of the Bohuslän fishermen in engaging in the herring fisheries is to earn money, and they will, therefore, choose that apparatus which promises the largest income. The Bohuslän fishermen do not care in the least for the highly scientific theories promulgated by the Stockholm Academy, and all attempts to induce them to abandon an apparatus which has proved profitable will be futile. Professor Nilsson was fully aware of this, and declared openly that floating-nets could only be generally introduced at Bohuslän if the use of seines was prohibited. As there is no longer any talk of prohibiting the use of seines, the victory of this apparatus may be considered complete.

In developing the fishing industries it is impossible to do everything at once and to introduce every possible improvement at the same time; but the proper way is to follow a well-arranged plan, according to which new improvements will gradually and in a perfectly natural way gain ground. Such a step towards a wise development of our herring fisheries is the introduction of the purse-seine, as thereby not only our herring fisheries will be greatly furthered, but also our deep-sea fisheries will be saved from extinction, to which they are otherwise certainly doomed. The last official report on the Bohuslän sea fisheries can no longer conceal the sad facts, but makes the statement that the fishing fleet engaged in the bank fisheries in 1882 decreased by 22 vessels. The floating-net fisheries, on the other hand, as the experience of Germany and other countries teach us, do not form such an advantageous starting point for a new development of the sea fisheries. There is a great difference between endeavors to introduce an apparatus like the floating-net, whose use is uncertain and in which the fishermen have no confidence, and the attempts to make the use of the purse-seine more

general. The floating-net, moreover, can be used largely only at a considerable distance from the coast, and is thus much dependent on the weather, while the purse-seine can be used near the coast and under conditions that are more favorable and encouraging.

Purse-seine fisheries also have the great advantage that they teach the fishermen to seek the fish and to cross the sea in every direction with swift vessels, a pursuit which is admirably adapted to the character of our Bohuslän fishermen.

With regard to any plans for promoting the herring fisheries, it will at once become evident that the principal and foremost means for obtaining good catches will be to further and facilitate in every possible way the sale of herring, for only if a good market and high prices can be obtained for the fish is it possible properly to develop the fisheries. As it is impossible to dispose of, while fresh, the vast quantity of fish caught by our fishermen, the only way to dispose of them advantageously is to prepare the greater portion of them for the market. It will therefore be evident that it would be very imprudent at this juncture for the Government to introduce an apparatus which presupposes a ready market and a high degree of perfection in the manner of curing fish. Much might be learned in this respect from Scotland, the very country which some of our theorists imagine that they are imitating. In Scotland many and strenuous efforts were made and great sums of money were spent in order to establish herring fisheries on the Dutch plan, but all these endeavors proved futile; but since efforts were directed towards finding new markets for the herring, and towards preparing a first-class article, the fishing industries began to develop very rapidly and a new form of herring-fisheries peculiar to Scotland was developed on a truly national basis, and the Scotch herring-fisheries became the first of the world, as far as the total value of the fish is concerned.

What is needed, therefore, to promote the Bohuslän-herring fisheries is, first of all, to introduce the Scotch method of salting herring, and, secondly, to adopt the Scotch herring barrel. If this had been done, instead of having these innovations opposed for such a length of time by Mr. Von Yhlen, the Bohuslän herring industry would even now stand very high.

XXIX.—SALTING FISH IN JUTLAND.*

By C. TROLLE.

To preserve fish by salting, two different methods may be employed, namely: Dry-salting, principally used for fish which are to be prepared as klip-fish by pressing and drying; and brine-salting in barrels, tubs, or tight boxes, which latter process produces an article that is ready for the market without any further preparation. In some parts of Norway and Scotland, however, fish which are to be dried are first laid in brine, in order to obtain (as people say) a heavier article. It is uncertain how far this is correct, but at any rate it is a saving of salt.

It is difficult to say which of the two above-mentioned methods is better suited to our circumstances on the west coast of Jutland, and which of the two products will meet with the readier sale. We can simply state that klip-fish is better known in our country, is easier to keep and to transport, and that we have already some experience in preparing klip-fish on our sandy western coast; while fish salted in barrels are liable to be damaged if the barrel should leak and some of the brine run out, which can easily happen during transportation. The raw material used in this process should be exclusively large cod and ling; while small cod, haddock, coal-fish, torsk, &c., can also be prepared as klip-fish.

Before giving a description of the method employed in salting fish, it may be interesting to make some calculations to show under what circumstances it will pay better to salt fish than to sell them fresh. As a basis for these calculations I shall use the data which I gathered during the Iceland fisheries, when I took frequent observations relative to the weight and dimensions of fish when solid, cleaned, salted, and otherwise prepared, and to the quantity of salt used. I have by these observations obtained the following averages:

From solid or "round" fish (*i. e.*, fish as they come from the water) the following percentages are taken by the process of preparation for use:

	Per cent.
(*a*) By removing the entrails (the liver takes up 1.80 per cent)	14.20
(*b*) By cutting off the heads	19.76
(*c*) By scaling the fish	5.58
(*d*) By dry-salting	23.33
(*e*) By drying	10.11
(*f*) By trimming the fish	0.95
Total	73.93

* From *Fiskeritidende*, Nos. 44, 45, Copenhagen, October 28 and November 4, 1884. Translated from the Danish by HERMAN JACOBSON.

In other words, a dried klip-fish weighs only about 26 or 27 per cent. of its weight when it came out of the sea; or 100 pounds of fish as caught make about 27 pounds of dried klip-fish. If we count 22 pounds of Liverpool salt (at $\frac{4}{5}$ cent a pound) for salting 100 pounds of solid fish, and the cost of labor in cleaning, salting, and drying at 9 cents per 100 pounds, we shall not be far out of the way when we say that the cost of preparing fish is 1 ore [100 ore=26.8 cents] per pound of its weight as solid fish, which, however, is easily made up by making proper use of livers, sounds, &c.

As the average wholesale price for klip-fish is 20 ore a pound for large codfish, and 15 ore for small codfish and haddock, the net profit would be $19\frac{3}{4}$ and $14\frac{3}{4}$ ore, respectively, per pound, while if the same fish had been sold fresh it would have fetched, respectively, 5.33 and 3.98 ore per pound. From the above it will appear that it is not profitable to prepare fish as klip-fish unless the fresh fish cannot be sold at all or must sell at prices lower than 5.33 and 3.98 ore per pound. It should be stated that in selling fresh fish on the shore the entrails are counted in when the fish are weighed; if this is not the case, 14.20 per cent. should be added to the above-named prices, so that, all the other conditions being the same, they would be 6.08 and 4.52 ore per pound.

As many small fish, especially haddock, are caught on the west coast of Jutland, where the fisheries are frequently carried on near the coast, it should be stated that the minimum dimensions of klip-fish in trade are the following: For large fish, 16 inches from the lower edge of the neck-bone to the root of the caudal fin (*a b* in Fig. 1) when prepared, which would correspond to 26 inches of a solid fish, full length (as A B in Fig. 2); and for small fish, 10 inches when prepared, and 19 inches when solid, full length.

METHOD OF PREPARING FISH.—The principal condition for obtaining a durable and good article, either of klip-fish or salt fish, is a careful and cleanly preparation of the fish in all the stages of the process from the time they are taken out of the water. The fish should be killed immediately, or at any rate soon enough to let the blood flow out freely and to prevent it from coagulating inside the fish. The fish is killed by cutting its throat close above the neck-bone. The cut should be so deep that the cervical vertebræ are cut through, as otherwise the bleeding will not be complete. If the neck-bone was not retained in the klip-fish, it would not have the necessary degree of stiffness when dried. Care should be taken not to throw the fish or to tread on them. If it hangs loosely upon the hook, and therefore has to be caught near the surface of the water with a hooked spear, the hook should, if possible, be inserted in the head; for where this is inserted the fish will have a bloody spot, which when found on the body will class it among the damaged fish. If the fish cannot be cleaned immediately, it is advisable occasionally to pour some water over it, in order to prevent the slime

and blood from adhering to it. At the very latest, the fish ought to be cleaned four hours after it has come from the water.

Cleaning and trimming the fish is done in the following manner:

Take hold of the fish round the snout or by the eyes with the left hand, lay its neck across the edge of the cleaning-vessel (the belly, therefore, upward), and cut off the head by a cut across the cervical vertebræ, running obliquely upward along the edge of the gill-cover (see the dotted line in Fig. 2). By inserting the point of the knife in the tail end, the belly is slit open by an upward cut through its center, the knife being carried up all the way through the gullet, midway between the ventral fins. (The double line shows the cut in profile.) The entrails are taken out, the liver and the roe being laid aside in separate vessels for special treatment. Care should be taken not to cut the gall-bladder and to remove every particle of the liver, as otherwise the fish is apt to get a yellowish color. The fish is then laid on the trimming-board, the tail turned toward the trimmer, the belly on his right-hand side. In order to cut out the backbone the point of the knife should be carefully guided along the outer edge of the backbone, and a straight clean cut should be made along the entire length of the fish from the neck along the backbone through the anus and the root of the anal fins clear to the center of the caudal fin, inserting the knife no deeper than is absolutely necessary for cutting out the backbone. The skin should not be taken off. The fish is then turned, so that the neck is toward the trimmer; by an oblique cut the backbone is cut a few vertebræ below the anus (therefore nearer to the tail); the cut should go through two vertebræ. From this cut another one is made upward toward the neck, therefore toward the trimmer, by letting the blade of the knife run closely under the still adhering lower side of the backbone, so that it can easily be torn out. By first loosening the backbone and then cutting it (one will not always be able to do this in the exact place where the backbone is loose) a piece of bone of the remaining tail-bone will then protrude, and the meat underneath it is apt to become sour in drying. The knives which are used in trimming must be sharp, so that the cuts may be even and clean. In sharpening the knife the point should be rounded off (see the dotted line in Fig. 3, which shows a good trimming knife in its natural size) so as to prevent the cut along the backbone from being so deep as to render the skin visible on the flesh side. The handles of the knife should rest easy in the hand, and the blade should not be too long. If the fish is frozen it should not be trimmed before the ice has been thawed off, which is easily done by laying the fish for a couple of hours (no longer) in a vessel with salt water, or, better still, a weak brine. Immediately after having been trimmed the fish should be put in salt, as it should not be salted when frozen.

At the same time when the fish is trimmed, it is washed; or, if there are not hands enough, immediately after it has been trimmed. The fish are washed in larger vessels (such as petroleum barrels cut in half) and

in salt water which should frequently be changed. The use of fresh water is said to make the fish slimy. With the left hand the fish is seized by the tail, and while water is constantly poured over it, the blood is pressed out from the remaining portion of the bone with the thumb, while at the same time the tail is twisted a little. With the right hand the black membrane of the stomach is removed, as well as all impurities, and particles of slime and blood. Special care should be taken to clean the neck-bone, and to brush off all slime under the pectoral and dorsal fins. To make the cleaning process easier, woolen gloves are used. Some foreign fishermen use brushes, but as the bristles easily tear the flesh, gloves are preferable, at any rate for cleaning the flesh side. It cannot be repeated too often, that the last drop of blood must come out of the bone; and in preparing brine-salted fish the Scotch cut across that part of the backbone under which the veins are hid.

In order that the water may flow off, the washed fish are laid in small piles, the skin side upward (except in the lowest layer) and the necks the same way, turned inward toward the middle of the pile, the layers of which should be arranged like rays. The piles should not be too high.

The salting should take place within 12 hours after the fish have been caught, if a first-class article is desired. If the fish are to be dry-salted, some boards are placed in a slightly inclined position, so that the brine, which contains some slime, can flow off; and these boards should be placed on stones so high that the water at the bottom of the vessel cannot reach the lowest layer of fish. On these boards enough salt is strewed barely to cover them. On these boards the fish are placed in horizontal rows across the boards (when on board a ship, across the entire breadth of the ship), alternately with the tail outside and the neck outside (as shown in Fig. 4).

Three or four rows of fish generally form a layer, which is as long as the space will permit. Several layers, one on top of the other, all with the flesh side downward and salt sprinkled on each, form a pile. The breadth of the pile (3 or 4 fish lengths) is determined by the distance to which the salter can reach, so as to spread them out evenly without treading on them. The pectoral fins should be bent over. Fish of the same layer should not cover each other in a single spot, unless this spot is well covered with salt; otherwise the fish will in these places assume a yellow color, and be classed among damaged fish. On board a vessel the height of the pile should not exceed 3 or 4 feet, before the fish have settled. If the catch has been good and therefore all the fish in the pile are soft and freshly salted, the pile is apt to be loose and may easily tumble down, whereby many fish are damaged; moreover, it is inconvenient to salt a very high pile.

In view of the limited space on board a vessel, the fish may be piled up a second time, when they may of course be piled up clear to the

deck; but this should not be done unless the fish have lain in salt at least 3 days, or 72 hours. The salt adhering to the top layer should not be shaken off; and care should be taken to salt again those fish which may need it, as will be seen from the fresh color of the flesh. The fish are piled up a second time by persons who intend to sell them in a salted condition to the curers. By piling the fish up a second time, so that all the necks are turned outward, the pile will become deeper in the center; the fish will retain more moisture and therefore weigh heavier than if they are kept constantly in the first pile, from which the brine runs off. It is evident that this method proves unprofitable to the person who is going to cure the fish, as it will have to be pressed more, and will therefore shrink during the drying process. It should also be stated that the flesh of the fish becomes whiter where it is not piled up a second time.

As regards the quantity of salt to be used for a certain number of fish, experience has shown that the less the amount of salt required for preserving the fish, the better it will be. This does not imply, however, that the salt should be used in a stinted manner. The thinner and leaner the fish, the less salt they will need; and an even layer of salt, barely covering the fish and leaving no vacant places, will be sufficient. In warm weather more salt is needed than in cold weather. Fish which are to lie in salt for some time before they are cured, must be salted more than fish which can be dried soon after the salting. It does not matter much what kind of salt is used, so it is clean, white, and even and fine-grained. It is advisable, however, to use coarser salt, in preference to the fine Liverpool salt, for fish which are to lie in salt for some time, as it does not form brine so quickly. Care should be taken that no iron articles are left lying in the salt, as the rust spots caused thereby will damage the fish. Excessive use of salt draws all the juice out of the fish, and does not increase the weight; moreover, a salt crust is apt to form on the fish during the drying, which may cause the fish to become "salt-burned." Too little salting, on the other hand, exposes the fish to the danger of decay. During the summer months, on board a fishing vessel, where some salt is always spilt and where the fish can be salted in the course of several months after they have been caught, about 300 pounds of salt should be used for 320 pounds of cured fish, or in other words 300 pounds salt for 1,200 pounds solid fish as they come out of the water. On shore hardly as much salt is needed. The Norwegians count 650 pounds salt for 1,000 pounds cured fish; but in Norway nearly all the salting is done on shore, and the fish are dried very soon after they have been salted. Fish may be salted in the open air; in that case, the pile should be under a roof of boards and be well covered with mats.

We shall now describe the drying process according to the method employed in Iceland. The most suitable place is a narrow tongue of land exposed to the air on all sides. Here a bed of stones and pebbles

is made. No sand should be underneath; so, wherever there is sand a layer of sod is spread; gravel, however, is preferable; and the place should be so arranged that the wind can strike the fish at the same time on the skin and flesh sides. Somewhat pointed stones are therefore chosen, which are laid with a small space between them. When the drying is to begin the salt fish are taken off the pile and are again washed, this time by using a brush. All loose salt, slime, and impurities, especially around the neck and back of the fins, are removed; and the fish are washed in clean water several times. The Icelanders wash the fish on the benches of a boat drifting with the tide.

After the fish have been washed they are conveyed in wheelbarrows to the drying place and laid out there in small star-shaped piles, the necks turned toward the center of the pile and the skin side upward, with the exception of the lowest layer. In this way the fish are allowed to lie until the water has run off.

When the weather is dry the fish should then be spread out as soon as possible. Each fish is spread out smoothly on the stones, the skin side downward, and so that one does not cover the other. The principal thing needed for drying is wind, and care should be taken not to expose the fish to the strong noonday heat of summer, as they are apt to become sunburnt instead of being dried. The flesh side is generally turned upward till within a few hours before the fish are piled up in the evening, when they are turned so that the skin side may also become dry. When the air is moist, as in foggy weather, there is no use in spreading out the fish. The sharp spring winds will dry the fish most rapidly; but, as a general rule, the fish are spread out every morning, are turned a few hours before evening, and are piled up for the night.

After the drying process has begun the fish should be spread on two consecutive days, as they do not bear much pressure before they are about half dry. If the condition of the weather renders it necessary to keep the fish piled up for several days, they should be rearranged several times. Until the fish have become about half dry they can easily stand a little shower, but not during the last days of drying, when some sunshine is needed so the flesh may become white. If the fish are to be sheltered from a shower, they should be piled up as quickly as possible in small heaps, with the skin side upward. If the shower does not last long, it will be sufficient to turn each fish in its place; if the rain continues, however, they should be piled in larger heaps, which are covered with mats and a roof of boards.

Under favorable circumstances the fish are completely cured after having been spread four days. Between the second and third spreadings the fish are pressed for one day by being gathered in large heaps and covered with boards, on which heavy stones are placed. As a general rule, the same weight of stones is used as the weight of fish in the pile. Between the third and fourth spreadings the fish are also pressed, ac-

cording to circumstances, for one or two days. After the fish have become half dry they are always kept in press during the night. If there is a chance to sell the fish quickly, it is thought, at least in Denmark, that it is unnecessary to cure the fish so hard, and it may possibly be sufficient to press the fish during the night. In Iceland klip-fish is considered ready for the market when the flesh is so elastic that no impressions remain anywhere when the point of the finger is pressed against the fish. Salt fish and klip-fish should be stored in a dry place where there is no draft.

We will now give some information relative to the preparing of klip-fish on the west coast of Jutland, furnished by a member of the Association for the Promotion of Fisheries in Denmark:

"As soon as the fish have been landed they are cut open, carefully cleaned, and laid in large vessels with a layer of Lisbon salt between every two layers of fish; about 1,600 pounds of salt are used for every 100 codfish; and the fish remain in the salt from 6 to 8 days. They are then taken out of the salt and stacked in heaps, each holding about 100. The following day, if the weather is dry, the fish are spread out in a dry and even place in the fields, which is first covered with a thin layer of fresh straw so that the fish may not be injured by the moisture of the grass. In the course of three or four days the fish are dry enough to be piled up in heaps until the drying process proper begins. Haddock are treated in the same manner, 320 pounds of salt being used for 200 or 240 fish, according to size. Of late years klip-fish, especially cod, have found a ready sale and brought good prices. Haddock, which are generally very small, have, as salt fish, not met with a steady demand, and have frequently had to be sold fresh. It will be evident that it will not pay to salt haddock, when we state that they cost on the shore from 16 to 20 cents per 20 fish, and that it takes from 40 to 50 salt haddock to make a *lispund* [16 pounds], and that the price for cured haddock is only from $2\frac{1}{2}$ to $3\frac{1}{4}$ cents a pound."

SALTING IN BRINE.—The so-called *laberdan* (brine-salted fish) is principally prepared from cod and ling. As regards the cleaning and trimming of the fish the same rules apply as have been given above; only the salting is different. In preparing this article it is still more important that the fish should be killed as soon as they come out of the water, and that the curing process should begin at once. After the fish have been trimmed and washed they are packed tightly in solid barrels, the skin side downward, the fish bent to follow the curve of the barrel and the tail bent upward. Salt is put at the bottom of the barrel and between every layer of fish. The barrel is packed so full that several layers are above the edge; the uppermost layer must be turned with the skin side upward. The fish are then allowed to stand for several days in order to settle; and when they are taken up, the slime is carefully removed with brushes, and they are salted over again in different barrels, with a fresh supply of salt. They are tightly packed and again

allowed to stand several days, when they are well pressed by means of a regular press. The barrel should be full to the brim when the lid is put on.

The quantity and quality of the salt used varies. On an average from one-fourth to two-fifths of a barrel of salt is used for one barrel of fish. Coarse kinds of salt, which do not melt so rapidly, are preferred. The number of fish in each barrel varies from 30 to 60. A barrel of fish weighs 260 pounds net, and the price varies in Holland between $9.38 and $16.08, and in England between $13.40 and $18.76.

The gullets and tongues are salted separately; and in Holland and Belgium bring 50 per cent. more than the fish. Among other products of the cod which may be used, we must mention the liver, roe, and sound.

If the liver is large and white it may be used for making medicinal codliver oil, which can easily be done without the aid of any expensive apparatus. All that is necessary is the following: Take a good-sized iron pot and have a tin kettle made measuring 2 inches less in diameter and being somewhat higher. The kettle should rest on the edge of the iron pot by means of an iron rim which entirely closes up the opening. The bottom of the kettle should be about 2 inches from the bottom of the pot. The kettle has a valve which serves to let the steam escape, and for pouring water into the pot. The space between the pot and the kettle is filled with water about two-thirds of its height. This water is made to boil and kept boiling; the temperature developed thereby in the tin kettle will be about 100 degrees Celsius. White cod-livers, which have been well washed and cut in pieces, are put into the kettle. If the livers are to produce medicinal oil, they should, however, not be more than two days old. When the liver has come to boiling, the clear white oil will float on the top, and should be skimmed off and temporarily be placed in a dry tin vessel in order to settle. The oil will begin to make its appearance in the course of a few hours, and care should be taken always to have plenty of water in the pot in order to prevent the heat from becoming too great and thus burning the liver, and to stir it often. The kettle containing the liver should not have a lid. As soon as the oil begins to turn dark, it is no longer fit for medicinal oil and should be kept separately. As soon as the clear oil has settled in the tin vessel it is poured into dry, clean tin cans, tin-lined barrels, or glass bottles. The oil should be carefully kept from all contact with the air or moisture; the corks should, therefore, be securely sealed, and the vessels containing the oil kept in a dry place.

The settlings of the livers may, by strong cooking, or by exposing them to the heat of the sun, be used for producing brown oil. This same oil may also be gained direct from the livers by simply letting them lie on frames, and decay or ferment in the heat of the sun. This oil, however, has not so strong medicinal qualities as the clear oil. If we remember that the liver is about 1.80 per cent of the weight of the

solid fish (or about 5½ per cent of the cured fish), it will be seen that it forms an important product of the fish. According to the fatness of the liver the yield of oil will vary between one-third and one-half, and will of course depend to some extent on the thoroughness of the boiling process. The general price for good codliver oil is about 13½ cents per pound.

The roes are salted in the same manner as the fish in boxes or barrels, which are perforated so that the brine can run off. The roes are then carefully packed and shipped to France and Spain, where they are used as bait in the sardine fisheries.

The sounds are cut from the backbone and scraped, and while they are still fresh they are washed and spread over boards and finally dried. There are generally from 50 to 100 sounds to a pound, which is sold at from 16 cents to 27 cents.

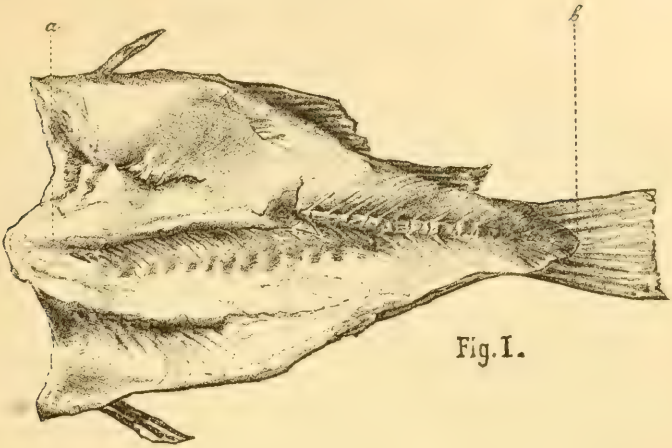

Fig. I.

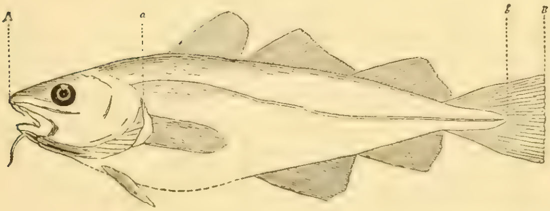

Fig. II.

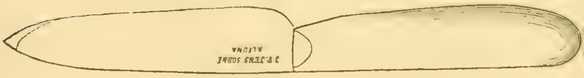

Fig. III.

Fig. IV.

XXX.—THE SALTING OF HERRING.*

Just as there are sick people, who, after it has taken years to destroy their health, want the physician to cure them in a few days, so there are persons who demand of a guide for preparing fish, that it shall give rules how to obtain a good product in spite of a poor raw material and careless treatment. To such persons we can simply say that the only secret known consists in exercising the greatest care during the entire treatment. This is absolutely necessary, and neglect in one point can easily counterbalance all the care exercised in other directions. It is impossible to lay down binding rules for preparing fish, nor would it under all circumstances be possible to follow these rules. All that can be done is to lay down some fundamental principles as regards the best method to be followed during the different stages of the process of preparation. Only by following these principles in every respect can one expect to obtain a first-class article. In the good old times the authorities took care of such matters in a fatherly way by issuing orders and decrees.† It is true that we find in these decrees the principles whose correctness is recognized even at this day, and which are followed in their main outlines; but, although these rules laid down by law had their advantage, by contributing towards a careful method of preparing fish, and by guaranteeing proper care, they were, by the obligations which they imposed on people, in other respects, impediments in the way of a proper development of this industry, and often exercised an injurious influence. These decrees have therefore been abrogated, but their leading ideas have been retained in the present laws, for instance, in those requirements which in several countries are necessary for obtaining the Government stamp. Compulsory stamping has been abolished ‡ by our more liberal laws, and it is left to the manufacturer to make the most, and we may also say, the least, of the raw material. Optional stamping, however, still prevails in many places,

*"*Saltning af Sild.*" From *Norsk Fiskeritidende*, Vol. III, Bergen, January, 1884. Translated from the Danish by HERMAN JACOBSON.

†The oldest of these which are known are the Ostend decrees of 1177; those of Amsterdam, of 1511, 1527, and 1579; and the Scotch decrees of 1148.

‡In Sweden in 1774, except for herring caught outside the coast waters, for which it was not abolished till 1853; in Norway in 1852; in Holland in 1857. In the last-mentioned country all official stamping was abolished in 1878. In Scotland stamping was only compulsory for those herring for which the Government, with a view to encourage the fisheries, paid a premium; and compulsory stamping and the system of premiums ceased in 1829. Stamping at present is optional, but about two-thirds of all the herring exported are stamped at the request of the manufacturers.

so that there is some inducement for the manufacturer to have goods, which have been prepared according to standard principles, recognized by an official stamp. In the following we shall give a brief review of these principles. We do not claim to give anything new, but only repeat what, in part at least, has been known for centuries.

THE RAW MATERIAL.—The first condition for obtaining a first-class article is to have good raw material. It is well known that the herring which are caught vary greatly as to size, age, fatness, and development of the sexual organs. The influence which these differences have on the value of the goods will be spoken of later under the head of Sorting. The point to which here we desire to call attention is that the herring, from the moment it is taken into the boat until it is delivered to the manufacturer, must be treated with the greatest care, and that the manner in which the raw material is treated has a great influence on the value of the manufactured article. Whenever a net has been hauled in, the herring should at once be shaken out of it, for nothing is more injurious for them than to lie packed in the net, whereby they b come soft, more or less spotted, and are apt to lose some of their scales. The board of fisheries lays great stress on this, and speaks in strong terms against the injurious habit of letting the herring stick in the nets after they have been hauled.* The herring should be protected against the influence of the weather by being covered with tarpaulin, especially when the sun is hot, so as to prevent their becoming sunburnt.† Care should also be taken that the herring are not trodden upon. The boat should always be kept free from water, for which purpose each boat should be supplied with a pump, whereby the work is very much facilitated. We must finally call attention to the circumstance that tarred boats should not be used until they are thoroughly dry, and that the vessels used for fishing and for carrying the fish must constantly be kept clean.

When fresh herring are transported, not too many should be crowded together; and special care should be taken in this respect with fat summer herring. The decree dated June 29, 1775, relative to the better management of the Bergen herring fisheries, prohibited the carrying of more than 24,000 in one load, which number, by provisional decree of November 24, 1821, was increased to 60,000. This decree was abrogated by the law on the herring fisheries of April 25, 1863, so that now every one can put as many in one load as he pleases. The vessels used for carrying the herring should, however, be divided into compartments by boards running lengthwise, and by some running cross-

*Attention was already called to this matter by circular of June 22, 1816, but, as it seems, with very little result.

†By the decree of June 29, 1775, it was prohibited to take summer herring from the nets till one or two hours after sundown, or before 10 p. m. and after 5 a. m. All the fish taken outside of those hours could be prepared only for the use of farmers as an inferior article.

wise, so as to prevent the herring from pressing too heavily against each other.

If we compare the conditions under which the raw material is obtained in the Norwegian, Scotch, and Dutch fisheries, we find that they are most favorable in the Dutch fisheries, as the salting is done exclusively on board the vessels by which the herring have been caught, the herring being put in the salt direct from the nets. Where the salting is done on shore the length of time which will elapse before its effect can be felt will depend on the distance between the place where the fish are caught and the salting place, either a salt-house or a vessel. In this respect the Norwegians are more favorably situated than the Scotch, partly because the fisheries are carried on nearer the land, partly because the majority of the herring are caught with nets from which they can be taken alive and conveyed direct to the salt-houses. As regards freshness, the Norwegian net-herring stand higher than the Dutch seine-herring, whose salting place is near to the place where they were caught, and we have here, provided the herring are of good quality, the first condition for obtaiing a first-class article. If it becomes necessary to convey the herring some distance, they lose their freshness and therefore their value. In Scotland herring which are put in salt later than 24 hours after they have been caught cannot get the official stamp. Similar distinctions are made in the Netherlands, and occasionally a distinction is made even between the fish taken from the net first and those taken last. The preparation or curing of fish, therefore, begins, if circumstances permit, during the fisheries. In Norway, after the rules relative to the preparing of herring had been abolished, the proper distinction has not always been made between the herring prepared in the place where they had been caught, and those which had to be conveyed by vessels to more or less distant salt-houses, unless they were absolutely spoiled. Some people have even gone so far as to prefer old herring in which the process of decay had already begun. What stress was laid, even in former times, on putting the herring, when quite fresh, in salt, may be inferred from the circumstance that in the times of Queen Margaret [1353–1412] and Eric of Pomerania [1389–1459] it was a capital crime to salt spoiled herring. There are, however, such differences in the raw material, that in a national herring trade some regard should be had to them. By ignoring these differences one runs the risk of having the foreign buyer judge the whole lot of goods by the worst specimens, whereby the difference in value which really exists is lost to the manufacturer or the shipper.

SALT SPRINKLING.—The next condition for obtaining a good article is that the herring should be put in salt as soon as possible. In olden times it was customary to throw them into strong brine before they were salted down in the kegs, which, however, cannot be recommended, as thereby they lose too many scales and become soft. At present salt is sprinkled on the fish. The Scotch sprinkle the herring freely with

salt in special vessels, as soon as they have been brought on shore, a second time after the fish have been cleaned, and again prior to their being put into the kegs. The Dutch roll the herring in salt, in dishes specially made for the purpose, as soon as they have been cleaned, and only a few hundreds at a time, so the work can be done carefully. For sprinkling, the Scotch use Lisbon or coarse Liverpool salt, or a mixture of both, while the Dutch use fine Lisbon or St. Ives salt, one ton of salt to every eleven tons of herring. In Norway no salt touches the herring until they are put in the kegs. For this purpose we use, it is true, more salt than either the Scotch or the Dutch, but a great portion of it had better be used for sprinkling.

CLEANING.—Cleaning was first introduced in Holland towards the end of the fourteenth century, and its introduction is generally ascribed to an extensive herring dealer, Wilhelm Beuckels, who died in 1397. This process must be considered as one of the greatest improvements in preparing herring. Although the visit which the Emperor Charles V paid to Beuckels's grave at Biervliet, in 1556, in order to honor his memory, was more calculated to flatter the national vanity of the Dutch than to thank Beuckels, even in his grave, for the great pleasure and enjoyment (as an old author naively relates) which he had given his Imperial Majesty by his method of preparing herring, Beuckels, nevertheless, deserves the gratitude of later generations.

Every herring which is to be smoked should be cleaned before it is salted. The object of the cleaning is:

1. To get the blood out of the herring, which is done by removing the gills, the throat, and the heart;

2. To remove those parts which, before the salt penetrates them, are most liable to decomposition, or which contain matter which is already in a state of decomposition (the stomach and entrails); and finally,

3. To give the brine as free an access as possible.

The Scotch remove the gills, the throat, the pectoral fins, the liver, heart, stomach, and sometimes the cæcum, if the herring are to be exported to the West Indies or to other countries outside of Europe. The Dutch do not remove the cæcum, partly for the sake of appearance, partly because many people think that it imparts a particularly pleasant flavor to the herring. In Labrador and Canada the entire belly of the large herring in summer is cut open, and is cleaned before they are salted. With our summer herring we generally remove only the throat, the pectoral fins, and the heart, and with our spring herring in former times also the gills. By our method we reach only the first of the above-mentioned objects, namely, to let the blood flow out, and this only partly. The parts which are most liable to decomposition are left in the fish. Many people do not clean the herring, but salt them as they are, or clean them only after they have lain in salt for some time, more for the sake of appearance than for any practical use. A common way of ascertaining how far the herring has become a prey to corruption is to

tear it open at the back and smell the backbone. That this is the place where the unpleasant odor will be noticed soonest is owing to the fact that the corruption spreads more rapidly through the veins filled with blood which extend along the backbone than through the fiber of the muscles. By taking the stomach out in time the greatest injury is prevented.

With a view of practically proving the importance of thorough cleaning Mr. Buch made the following experiments with herring, taken in seines outside the Jæder, towards the end of June, 1880. All the herring used in these experiments were salted with the same quality and quantity of salt, and kept in the same place, viz., a cool cellar. All in all, four quarter-kegs of herring were salted. Of these those which had been salted whole were spoiled after 8 days, those which were only cut were spoiled after 14 days, those cleaned in the old Norwegian fashion were spoiled after 14 days, while those cleaned in the Scotch manner were entirely fresh and good after a month, and could, as to their flavor, be placed by the side of the finest Dutch herring. Mr. Buch has made similar experiments during the present year, and with the same result.

If many people in Norway have thought that the thorough cleaning could be dispensed with, the reason for this, as far as the spring herring are concerned, is that these fisheries are carried on during the spawning season, when the fish as a rule take little or no food. There are, however, many exceptions in this respect, partly caused by the different stages of development of the sexual organs, and partly by the more or less easy access which the fish have to their food. It is therefore no uncommon occurrence to find herring which are ready to spawn with a stomach full of food. In the Scotch, Dutch, and other North Sea fisheries it is customary to remove the stomach from the herring, unless they are intended for smoking, when they are salted whole. If we followed the same method of cleaning the herring, the products of our fisheries would rise in value. The gills, which are full of blood, should at all events be removed. As regards the summer herring, those which are caught in nets should certainly be cleaned according to the Dutch or Scotch method; those which have been caught in seines will, as a rule, not have any food in their stomachs after they have been in the seine for 4 or 5 days. There may, however, be circumstances when the fish have not been in the seine for that length of time, and in that case the stomach should be taken out, if the fish are to be kept. The principal reason why we do not clean the herring more thoroughly relates to the fat. In herring taken before the middle of August the fatty matter, as a general rule, is soon eliminated, and the fat turns to train-oil. In that case it should under all circumstances be taken out before the herring are salted, as it will not go away of its own accord, and as the train-oil, which easily hardens, is apt to injure the abdomen in which the process of separation is going on, as well as the brine. If

the fat is taken out before the herring are salted, a well-flavored article is obtained which will keep well, while the fat, which should be kept in separate vessels, will yield a considerable quantity of train-oil. From herring caught in autumn, however, the fat should, if possible, not be removed. It is true that it also often separates, but the cause of this is generally that the fish have not been put in salt soon enough, or have been pressed too hard, on account of having been packed too tightly when fresh. In former times fat herring have been thoroughly cleaned in Norway, for an order dated 1753 prohibited "to take out the fat, unless in some places it should be needed for special purposes." It is very desirable that this custom should again be generally introduced. As it always takes a certain time till the natural brine begins to form, Norwegian manufacturers generally fill the keg with 6 to 8 liters [about 7 quarts] of brine (one-fourth ton St. Ives salt to 1 ton of sea-water) as soon as the herring have been salted, and thereupon close the keg, in which the fish are packed loosely. By this method the entrails are soon brought in contact with the salt, and the contents of the stomach will in that case not tend to spoil the article. The Dutch, who are also in the habit of pouring brine into the keg before it is closed, prepare this brine by pouring sea-water over the parts which have been removed from the fish, but do not mix any salt with it. The pouring in of artificial brine should be recommended when it is so cold that the herring are exposed to the danger of freezing before the brine has properly penetrated them.

THE KEGS.—The quality of the kegs is of great importance. They must be strong, firm, clean, of even size, of a suitable shape, and made of good wood. Their strength will mostly depend on the thickness of the staves and on the number of hoops. The staves should be at least 15 millimeters [$\frac{6}{10}$ of an inch] thick. In this respect we have kept pace with the times, as we now generally use kegs the thickness of whose staves is 16 millimeters. Kegs of that strength should be made by machines, as the stave is too thick to be bent with the hand. In hand-made kegs the staves are therefore generally made a little thinner in the middle. As split staves are better than cut staves, they may be somewhat thinner. In our opinion the paring should be confined to the sharp edges, partly because it somewhat diminishes the thickness of the staves, and partly because a rough surface is better calculated to keep the hoops firmly in their position. As regards the number of hoops, the Dutch use 18 to 20 (10 to 12 + 4 + 4); the Scotch, 16 to 18 (9 to 11 + 3 + 4); and the Canadians, 20 (10 + 10); while we generally use 12 to 16, arranged by threes or fours, when they are of wood, and by sixes when they are of iron. These latter have proved very serviceable, as they will hold better than the wooden ones; but they have, as we think, this disadvantage, that the keg rests exclusively on the side, while in those having wooden hoops it also rests on the middle hoop. Kegs bound with iron hoops should therefore have thicker staves. As

iron expands when exposed to heat, the iron hoops are moreover apt to become loose, and as they easily become rust-eaten their disadvantages are greater than their advantages. Hoops made of hazel wood are stronger than those made of willow. To prevent the hoops from sliding, the outer main hoop should be nailed fast, and small pieces of wood should be placed between the outer and inner row of hoops, so as to keep them in position.

The firmness of the keg depends on the thickness of the staves, on the material employed, and on the manner in which it is worked. The thickness of the staves has already been referred to above. As regards the material, it should be of some kind of wood which will not let the brine ooze through. The poplar and the pine, whose wood absorbs water easier than the fir, are not considered suitable for making staves. The wood of trees grown on marshy soil is not good for this purpose, and wood which has been in water for some time should not be used under any circumstances. Even if by drying it quickly one should succeed in giving it a white appearance the brine will easily soak through. Pine wood can least of all stand moisture, while clean, fresh-cut pine staves are equal to fir staves. The kinds of wood usually employed are, oak (Holland), beech and birch (Scotland), pine and fir (Norway). Beech wood has the disadvantage that it is brittle and warps easily, for which reason the staves should not be too broad.* Oak wood, or resinous pine, or fir wood† will, more than other woods, give a peculiar flavor to the herring. Whether this is an advantage or a disadvantage will depend on the taste of the customers. In former times the preference which was given to our herring in the Polish and Russian markets was ascribed to the resinous flavor which the fir kegs gave to the herring, so that it even became necessary to repeal the order given by the Danish Government (under whose authority Norway was at the time) prohibiting the use of fir kegs. The customers of the Dutch, on the other hand, preferred the flavor imparted to the herring by oak kegs. In our opinion no wood should be employed which imparts a peculiar flavor to the herring, except for markets where a preference is shown for fish having such a flavor. The summer herring especially are apt to take the flavor of the wood. From the experiments made last year by the Society for the Promotion of the Norwegian Fisheries, it appears that spring herring do not so quickly take flavor from the wood.

As kegs, when stored away, are apt to fall to pieces, or at least to have their staves loosened, they are filled with water, but not longer than twenty-four hours before being used. It is not advisable to let them lie by the side of the vessel, as only part of the keg gets in the water. It is said that putting in every keg $1\frac{1}{2}$ liters [3 pints] of salt

*In Scotland the breadth of the staves generally does not exceed 152.4 millimeters [6 inches], except oaken staves, which may be 177.8 millimeters broad.

†Till the year 1874 it was forbidden in Scotland to salt herring in fir kegs.

brine while stored away will prevent the staves from becoming loose. After the keg has been filled with brine and closed, its firmness is tested by pressing the end of the keg which has been closed with a heavy piece of wood. Hidden leaks will show themselves after twenty-four hours, for which reason kegs should not be stowed away until that time has elapsed, and even then only after having been carefully examined. Kegs which have been used once should not be used again, except for inferior kinds of fish, and not till they have been thoroughly cleaned.

With regard to the capacity of the kegs it is, according to the law of July 28, 1824, the duty of the police and the customs officers to see to it that fish, roe, train-oil, &c., are not imported or exported at any place unless the kegs or barrels have the prescribed dimensions, viz., 118 to 124 pots [about 93 to 99 quarts], laws of April 11, 1863. Any person violating this law is liable to a fine of 4 crowns [about $1] and to have his keg (but not the contents) confiscated. Kegs of less capacity, should be eliminated wherever found, or if they are used at all should be specially mentioned on invoices, bills of lading, &c. If the price of Norwegian herring is lower than that of some other nations, the reason for this must, in part at least, be found in the size of the kegs. The standard capacity should be:

	Liters.
For a Norwegian herring keg [102 quarts]	116
For a Scotch herring keg (minimum)	121.2
For a Dutch herring keg (minimum)	125
For a Swedish herring keg* (minimum)	125.6
For a French herring keg† (minimum)	135.6
For a Canadian herring keg (minimum)	114

As regards the shape of the kegs, the curve should be sufficiently large to let the hoops catch hold firmly, but not larger than to be on a level with the upper edge of the nearest (wooden) hoop. For loading and unloading ropes are used, and not hooks. The kegs should be protected against the sun (and also against frost) and when on board a steamer they should be as far as possible from the engine.

SORTING.—Before the salting commences, the herring should be sorted, which is done while the fish are being cleaned, the person cleaning them throwing the different kinds into different baskets or tubs. Not much time is lost thereby, although this is often made an excuse for the careless sorting which is so much in vogue in Norway. All the damaged herring should, first of all, be picked out and salted by themselves. As regards the further sorting, it may possibly offer peculiar difficulties with us, as our fisheries are principally carried on with seines, into which herring of different kinds are more apt to enter than into the nets, but this should be no reason why the sorting should not be done more carefully than is generally the case.

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* Since 1843 the Norwegian herring keg is generally employed.

† "*Tonne*" of a net capacity of 125 kilograms; the new measure, the "baril," is to have a net capacity of 112 kilograms.

The leading principle in sorting should be to follow the division of the herring adopted by the Scotch and Dutch, and to some extent, also, by us.

1. Fat herring, including herring containing fat, or from which the fat has been removed, and with sexual organs little or not at all developed.

2. Full herring, which should be subdivided into milters and spawners.

3. Empty herring, having neither fat, roe, nor milt.

As each of the above-mentioned kinds are generally caught separately, the sorting will be easy; and as a rule it will not be necessary to sort the fish. Each of the above-mentioned kinds of herring should then be sorted according to their size, as is now done with the summer herring, using, however, a different nomenclature.

It is well-known that at present the summer herring are, in Norway, divided into "merchant's herring," "medium herring," "large Christiania herring," "small Christiania herring," "small herring," &c., names which do not indicate the same size under all circumstances. The size of each of these kinds not only varies in the different years, but depends a good deal on the individual taste of the manufacturer or buyer, and even sometimes, in one and the same year, on the different localities where the herring have been caught. The most rational method of sorting would be the one proposed by a contributor to our journal,* viz., to sort the fish according to their length, so that 0 stroke would indicate herring measuring more than 30 centimeters† [12 inches]; 1 stroke, from 30 to 27.1 centimeters; 2 strokes, from 27 to 24.1 centimeters; 3 strokes, from 24 to 21.1 centimeters; 4 strokes, from 21 to 18.1 centimeters; 5 strokes, from 18 centimeters [7.1 inches] and less; and to use the same system for indicating the different subdivisions of the three principal classes or sorts referred to above. As a margin is left of 3 centimeters, the greater or less fleshiness of the herring, to which some regard should be had in sorting, will also be taken into account. We pass by the fraudulent method of sorting, which consists in placing good herring at both ends of the keg and poor ones in the middle, and which will sooner or later meet with its deserved punishment, although this will probably not be so severe as the one given in the old Skanor and Falsterbo law, whose article 48 says: "Any person who, in salting herring, puts other than good herring in his kegs, shall, if found out, lose his life."

In conclusion, we would observe that by careless sorting, the good fish will, as a general rule, not bring the price which ought to be paid for them, and being found in bad company they will be judged accordingly. It is the same with herring as with human beings, they are judged by the company which they keep.

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* July number, 1882, p. 14.

† Under this category would come most of the spring herring, great herring, and Iceland herring.

SALTING.—No special rule can be laid down as regards the quantity of salt to be used, as this depends on the strength, purity, and solubility of the salt, on the length of time the herring are to be kept, on their fatness, freshness, and the place for which they are destined. A fat herring requires more salt than a lean one; a fresh herring, or one which has been cleaned, less than an old one, or one which is to be salted whole. Herring which are to be exported to tropical countries require more salt than those destined for countries that have a cold or temperate climate, when the salt should be coarse and not easily dissoluble. Herring which are intended to be eaten soon get less salt than those which are to be kept for any length of time, as the preparing is, to some extent, done at the expense of the flavor. The Dutch are, or rather were, the nation which used least salt, as the small quantity, 16,000 tons, which they annually brought into the market was sold immediately. They used the following quantities of Lisbon salt: In summer, 1 ton of salt to 5 tons of herring,* and in winter, 1 ton of salt to 6 tons of herring. As a general rule 4 tons of salt were counted to 14 full tons of herring, which would make 1 ton of salt to 3.5 tons of herring. The Scotch count 1 ton of fine Liverpool salt to about 4½ tons of herring, while in Norway 1 ton of St. Ives salt is counted to 4 tons of herring, when just put up, and to 3.2 when ready for shipping.

It is difficult to say to which kind of salt the preference should be given, as one and the same place produces different kinds of salt, and as the quality depends, to a great extent, on the salt harvest. The Scotch use Liverpool salt; the Dutch, medium coarse Lisbon salt; and we in Norway, St. Ives salt. Each one of these three nations seems to be satisfied with the kind of salt it uses, even if it should not meet with all the requirements. The Scotch Board of Fisheries says regarding the Liverpool salt, "It should be remembered that Spanish or Portuguese salt makes a better cured article than Liverpool salt." The main point is that the salt should be pure, and that a suitable quantity should be used. It should be borne in mind that fine salt melts easier than coarse salt, but that the salt which holds water makes a weaker brine. Wherever there is need of it, salt which easily dissolves should be used in cases where it is important that brine should form quickly, while coarse salt is excellent for filling the kegs, or for salting fish which are to be kept in store for a long time.

PACKING THE HERRING.—In this respect there is considerable difference between the Scotch and the Norwegian methods, as the Scotch lay the herring on the back, while we lay them on the side. In so far as the method employed influences only the looks of the fish, the difference is of very little importance, as the taste of the customers varies in this respect. As regards those herring whose stomachs have been taken out, it is of importance that they should be laid on the back, as in that case the brine can more easily penetrate the abdominal cavity.

* Counting in what was used for sprinkling.

FILLING THE KEGS.—The further treatment of the herring after they have been cured differs, according to whether they have been cured on shore or on board the vessels. We shall, therefore, briefly describe the methods used by the two model countries in this respect, Scotland and Holland.

*Scotland.**—While the fish are being put up, which is done under shelter, the keg is filled so that several layers of fish protrude over the edge, and a lid specially made for the purpose is put on the top. After two or three days the fish have settled down, when more herring of the same kind are put in, care being taken not to pack them too tightly. The keg is thereupon closed and laid on the side. Every second or third day it is turned, until the final filling takes place. During all this time a constant lookout is kept for leaks. If the leak is small it is stopped up, and if this is impossible the herring are transferred to other kegs. To obtain the official stamp the herring must have lain in salt at least ten days, not counting in the salting day and the day of the final filling. If, after this period has elapsed, the herring are to be got ready for shipping, the brine is allowed to run off through the bung-hole, which is then closed; one end of the keg is then opened, and, while being pressed, herring of the same kind, which have been salted on the same day, are put in the keg. For pressing, either the hands or a common press is used. The object is partly to avoid the filling in of more fish at the place of destination, and partly to prevent the air from entering. At one time it was thought the superior quality of the Dutch herring was owing to the circumstance that they were put up by men, and were therefore pressed more firmly than those put up by women. When a keg has received its full quota of fish it is closed, the hoops are hammered down, and the firmness of the keg is subjected to another test by blowing through a blow-pipe, which is inserted in a hole specially made for this purpose in the bottom. This hole is finally closed by a tight-fitting wooden peg. The keg is now laid on its side and some of the original bloody brine is filled in until it begins to flow over.

If the fish are to be transferred to another keg, they are emptied out, washed in fresh water, and after the water has flowed off they are put in other kegs, with coarse Liverpool salt, and new brine, made of clean salt, is filled in. To get the official stamp the cæcum must have been removed, and the kegs must have the full number of hoops at both ends. Besides the hoops, an iron band one inch broad is put round the keg at each end.

Holland.—Salting is done on board the fishing vessels in the morning, partly during and partly after the hauling in of the nets. The kegs, into each of which is poured a bucketful of the bloody brine, are not closed until all the fish have been salted, when they are let down into the hold of the vessel. After five to ten days the first filling in

* Principally according to Dr. Axel Vilhelm Ljungman's *Anteckningar rörande sillsaltning*, &c., Udevalla, 1832.

takes place, when, as in Scotland, the brine is first allowed to flow off entirely. Three tons are generally used to fill in fourteen. As regards the time for filling, it is customary not to do it too soon, as the herring are apt to shrink, but not too late either, as by lying in the brine too long they lose some of their scales and become flabby. As in Scotland, the brine is filtered before it is again put into the kegs. On returning to shore, the kegs are again filled. Fourteen kegs "filled at sea" will make thirteen to thirteen and a half kegs for exportation. This shows that the fish are packed firmly at sea.

In Norway, whenever fish are salted on board the fishing vessels, the kegs are left from one-half to one day, when they are filled, closed, and let down into the hold of the vessel, where they remain until they reach their destination. Many kegs, therefore, arrive at destination with hardly any brine. When being prepared for exportation many persons confine themselves to brushing off the topmost part of the brine, which is often full of train-oil and loose scales, to sprinkling salt all round the sides, and pouring in some more brine at both ends. Loose packing is the rule, and the brine which is poured in has never been filtered. It is quite right that all herring should be packed loosely during the salting process. After they have lain in salt ten to twelve days it is generally supposed that close packing will do no harm; and there is, therefore, no reason for the loose packing which is so common in Norway just prior to getting the herring ready for transportation. It must be considered injurious to let the herring lie in the brine while being shipped from the salting place, and the kegs should, therefore, be filled completely after ten or twelve days. It is said that our summer herring cannot stand close packing, as the fat is apt to be pressed out. Whenever the fat becomes loosened the formation of train-oil cannot be prevented, no matter how loosely the herring are packed; and it is, therefore, immaterial whether the fish are packed loosely or not. To draw off the brine, as is done in Scotland and Holland, when the kegs are to be filled, would be a great mistake, at least as regards those herring which emit train-oil, as the greater portion of this would remain in the keg. The method commonly employed is, therefore, the best, all things being considered. But, as has been stated before, the fat should be removed before the fish are salted, whenever it is loose, for the emission of train oil will continue, no matter how often the brine is changed or how often it is skimmed off, as is done sometimes. Whenever herring which do not emit fat are put in the kegs, the brine should be drawn off and filtered before it is again poured into the kegs.

From the above it will be seen that the defects in our method are principally the following:

1. That we are not particular enough as regards the freshness of the raw material.
2. That the herring are not thoroughly cleaned.
3. That the sorting is not done systematically.

4. That no salt is put on the herring until they are put in the kegs.
5. That the packing is done too late and too loosely.
6. That no proper regard is had to the purity of the brine during the final packing.

The reason why in Scotland and Holland greater care is exercised in the curing of herring, and that in those countries the herring trade is carried on in a rational manner, must be sought in the fact that the fish are, as a general rule, cured for the merchant or dealer, who, therefore, is at the same time a producer. When a merchant is nothing but a merchant, his principal interest centers in the difference between the price at which he buys his goods and that at which he sells them, or on the quantity of money which he can raise on his goods, their quality being of less importance to him. His main object is to get goods which will have a ready sale, that is to say, which will fetch a higher price than they are really worth. Unless the shipper is at the same time a producer, our Norwegian herring do not enjoy, as a rule, the reputation which they might and should have. There is no doubt, however, that their value could be increased, and that they could find a readier sale, if they were cured more carefully. This would prove an advantage both to the dealer and to the producer. It was to be expected that, as they have their interests in common, they would work together to reach the desired end. But as in Norway, as a general rule, both the curing and the selling of herring is done in small quantities, reforms could hardly be introduced unless the value of the product was recognized by a strict system of official stamping in which perfect reliance could be placed.

APPENDIX C.

FISH-CULTURE.

XXXI.—A REVIEW OF THE FAILURES AND SUCCESSES OF ARTIFICIAL FISH-CULTURE.*

By VON DER WENGEN.

Professor Malmgren, of Helsingfors, Finland, in his memorial addressed to the Bureau of Agriculture of the Imperial Russian Senate for Finland, recently published,† has spoken so strongly against the introduction of artificial fish-culture in Finland that it seems proper to make this question the subject of a thorough investigation. As Professor Malmgren honored me by sending me among others his pamphlet, I feel justified in thus publicly discussing it.

With a view of familiarizing the reader with Professor Malmgren's pamphlet I must give the following statements contained in it:

When the Imperial Senate began to consider the question of introducing artificial fish-culture in Finland Professor Malmgren was commissioned to visit the Russian Government fish-cultural establishment at Nikolsk (in the southwestern part of the Government of Novgorod), and to prepare a memorial on the subject. He went to Nikolsk in September, 1882, traveling by railroad from St. Petersburg to Waldaika (a distance of 250 versts [167 miles], 1 verst being equal to about 1,067 meters or two-thirds of a mile), and from Waldaika to Nikolsk (52 miles) by stage coach. Nikolsk is about 40 versts [27 miles] from Valdai, the principal city of the district.

The fish-cultural establishment of Nikolsk was founded in 1855 by Mr. Wrassky, the owner of the estate, on the model of Huningen, in a valley watered by a small brook. Everything was on a large scale. It comprises thirteen large and small ponds, which are fed from the brook. The hatching house is very conveniently arranged, and its apparatus can contain 2,000,000 trout eggs. As the trout and the *maräne* [a fish of the genus *Coregonus*], the two kinds of fish which were to be raised at Nikolsk, were not found in that neighborhood, the fish required for propagation had to be brought from St. Petersburg, therefore over a distance of about 330 versts [220 miles]. There are trout in waters distant from Nikolsk about 35 versts [24 miles], but it is only recently

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* *Professor Malmgren und die künstliche Fischzucht.* From the *Deutsche Fischerei-Zeitung*, Vol. VI, Nos. 44, 46, 47, 48, 49, and Vol. VII, Nos. 1, 2, 3, 4. Stettin, October, 1883, to January, 1884. Translated from the German by HERMAN JACOBSON.

† Translation in F. C. *Bull.*, 1883, pp. 363–381.

that a small number have been brought from there to Nikolsk for the purpose of propagation. Owing to the lack of spawn the Nikolsk establishment has never been worked to its full capacity. The largest number of eggs hatched in a year was 300,000, but generally it is only about 100,000.

It is not surprising that, under such unfavorable circumstances, the establishment did not flourish, and that its founder sunk in it his whole fortune. He thereupon formed an association, which spent 41,000 rubles [$30,094] on the establishment, without, however, being able to make it prosper, in spite of a subsidy of 30,000 rubles [$22,020] from the Government. The association was dissolved, and in 1868 the Government took charge of the unfortunate establishment. The expense of starting it was 100,000 rubles [$73,400], and, according to some estimates, even 200,000 rubles [$146,800]. At present the Nikolsk establishment belongs to the Government, and may be said merely to exist. For its maintenance 3,000 rubles [$2,202] are annually appropriated, of which sum 2,400 [$1,762] go toward the salaries of the various officials.

As has already been said, the establishment has been anything but a success. The neighboring lake of Pskov, which has been stocked by the Nikolsk establishment with *maräne* and trout (we are not informed whether it was *Trutta fario* or *Trutta lacustris*) has yielded only very insignificant results, as, according to the official reports in 1870, seventy-one *maräne* and six trout were caught, and in 1871 only four *maräne*. In this connection, however, I would say that fish like the *maräne* and the trout generally stay near the bottom of the lake the greater part of the year, and only rise to the surface during the spawning season. The results of placing in a lake young fish of these kinds cannot be judged by the number caught occasionally at other seasons, more especially as these fisheries depend greatly on the state of the weather. Observations relative to this question should, therefore, be taken during the spawning season. Whether this was the case as regards the lakes near Nikolsk cannot be learned from Professor Malmgren's pamphlet.

The Nikolsk establishment has evidently proved a failure, and it is probable that it will never reach a flourishing condition, nor will it, owing to its isolated location, ever become suitable for a school of pisciculture. The entire undertaking suffers from the circumstance that it was commenced on too large a scale and with a certain financial recklessness, instead of starting from a small beginning and gradually being enlarged as it showed signs of prosperity. Nikolsk is one of those unfortunate institutions which have been established in an entirely unsuitable location, but which one does not like to abandon on account of the large sums expended. Establishments of this kind drag out a sickly existence and are more hurtful than helpful to the cause, as they become discouraging examples. I therefore agree with Professor Malmgren in his unfavorable criticism of the Nikolsk establishment, but this is no reason why he should judge unfavorably of fish-culture in general.

RUSSIA.

Professor Malmgren takes occasion to remind the reader that for more than twenty years Finland possessed salmon-hatching establishments, which owed their existence to the impetus given by France through its establishment at Huningen. The superintendence of salmon-culture in Finland was principally in the hands of Professor Holmberg, of Helsingfors, who had studied artificial fish-culture in Norway. During the period of 1858 to 1864 salmon hatcheries were established on the Kymmene River, on the Wucksen (near Kexholm), on the Ulea, Tornea, and Urpala, which, however, were as little successful as some other establishments devoted to the hatching of brook trout and lake trout. Some of these hatcheries produced 100,000 young salmon per annum; Kexholm even as many as 200,000, without, however, causing any noticeable increase in the number of fish. Professor Malmgren simply mentions this fact, without telling us anything regarding the causes of the failure. I am inclined to think that probably one of the principal causes, as in many of the Swedish and Norwegian fish-cultural establishments, must be found in the use of warm spring water, which is more or less lacking in air. In countries of the latitude of Sweden and Norway spring water is used for artificial fish-culture, if possible near the source, because many of the waters freeze entirely during the severe winter. On account of its greater degree of warmth spring water is not so liable to freeze, but it is apt to develop the eggs and young fish prematurely, so that the latter have consumed the umbilical sac and are ready to be placed in open waters at a time of the year when everything is still covered with snow and ice. If these tender young fish are placed in open waters at this season they must perish, partly on account of their not being able to resist the severe weather, and partly owing to the fact that at this season of the year those insects on which they principally feed have not yet made their appearance. If these young fish were, at this season, placed in ponds and ditches, in order to raise them there, the fact that these waters would be more or less covered with a sheet of ice would be prejudicial to their growth. Under these circumstances it is not surprising that the young fish are decimated; and if, on the other hand, the fish-culturist wishes to keep the prematurely developed young fish in the hatching tanks till spring, he is obliged to supply artificial food, which, especially if the number of fish is large, will have its peculiar difficulties. At the same time the fish growing from week to week in the warm spring water, which more or less lacks oxygen, will not get the quantity of fresh air necessary for their development, and consequently large numbers of them will die. As fish-culturists in Sweden and Norway, where Professor Holmberg studied fish-culture, work with spring water, it is probable (although Professor Malmgren does not say anything about it) that this has also been the case in Finland. This sup-

position is confirmed by the fact that the impetus given to fish-culture in Finland came from France, and its model establishment at Huningen, whose operations were based on the spring water theory, that fatal theory which works on the supposition that success in hatching can be obtained only by keeping the water as much as possible at an even temperature. This very theory has proved very hurtful to the development of artificial fish-culture, for, owing to its application, many piscicultural establishments have failed.

In my review of the "Guide to Artificial Fish-Culture," by Mr. Hetting, royal inspector of fisheries for Norway, published in Circular VII of the German Fishery Association for 1871, and giving a sketch of fish-culture in Norway, I have pointed out the unsatisfactory results of the exclusive use of spring water (see Circular VII, 1871, pp. 42–45), and to this day fish-culture in Sweden and Norway is languishing from this cause. Mr. von Yhlen, royal inspector of fisheries for Sweden, in his article on salmon culture in Sweden, published in the *Deutsche Fischerei-Zeitung*, complains of the serious drawbacks of working with spring water, and advises to cool it with ice. But if spring water has not, for some time, flowed above the ground, the cooling with ice can not remedy the most serious evil, namely, the lack of air. In some establishments there is a contrivance for turning the spring water to a spray, and thus to saturate it with oxygen, before it enters the hatching apparatus. But this contrivance is of a somewhat complicated character, and requires special conditions of level in order to ob ain the necessary pressure for making the water rise; and even then it is doubtful whether the water, during the short time which is occupied by turning it to spray, is able to absorb enough oxygen to afford the necessary amount of air for large quantities of eggs and young fish. In large establishments it would, moreover, be very difficult to subject the necessary quantity of water to this process. I would advise all Scandinavian fish-culturists to choose for their establishments locations where they have both river and spring water; whenever there is any lack of river water, spring water may, in case of necessity, be temporarily employed, or mixed with the supply of river water. The artificial hatching of winter fish-eggs will yield favorable results only when the development of spawn and fish in the hatching house keeps step with the conditions of free nature, which can only be obtained by employing river, brook, lake, or pond water. I would, therefore, also urgently recommend for Russia, where efforts are now being made to spread artificial fish-culture, to study this important water question and decide it as indicated above. Unless this is done, there will only be new disappointments, which will cause people to take the dark view of artificial fish-culture which we find in Professor Malmgren's report. This report contains but little information relative to artificial fish-culture in Russia, and, owing to the lack of material, I am not able to supplement this report. Professor Malmgren mentions the efforts made by Dr.

Knoch, who in 1857 constructed carp ponds on an estate belonging to the Grand Duke Constantine Nikolajewitsch, as to the results of which, however, Professor Malmgren's report is silent. I remember, however, to have read somewhere that Dr. Knoch succeeded in artificially raising the sterlet, which fact seems to have been unknown to Dr. Malmgren. (Later I shall have occasion to revert to the fish-cultural establishment in or near Suwalki, in Poland, which seems to have been successful in raising *Coregonus* for the Raygrod Lake.) After mentioning the artificial hatching of trout and *Coregonus*, undertaken by Mr. Muschinsky, a banker of St. Petersburg, who had the young fish raised by him transferred to his estates in Poland, Professor Malmgren speaks of the Russian Fishery Association (founded in 1881 on the model of the German Fishery Association), whose president, Counselor von Greig, has established artificial hatcheries on his estates in Courland, which seem to be planned on a large scale. Our best wishes follow this young association, before whose activity a large field seems to be open. May its motto be in general, "The right fish in the right water." We hope that it will not waste its strength in irrational efforts, such as have been made in Russia by endeavoring to raise sterlets in ponds; but that it will engage in practical fish-culture, whose efforts are directed not towards forcing nature from its wonted course, but to make the life and habits of fish the basis in all undertakings of this kind. It is also to be hoped that the Russian Fishery Association will not be guided by *dilettanti*, whose efforts but too often resemble a straw fire, which soon burns out and leaves nothing but disappointment.

With his criticism on the Nikolsk establishment, Professor Malmgren combines a review of artificial fish-culture and its results in other countries, and arrives at the conclusion that nowhere have remarkably successful results been obtained. In view of this opinion of Professor Malmgren, I must state that he has certainly not made the necessary observations to enable him to come before the public with such a sweeping assertion. I have taken the trouble to collect data for refuting his statements. These data would have been more numerous if it had not been for the circumstance that this whole literature, not very rich in itself, was very much scattered, and often difficult of access. I have gathered my information principally from the circulars of the German Fishery Association and from the files of the *Deutsche Fischerei-Zeitung*, those publications which, during late years, have furnished the most important information relative to the subject of artificial fish-culture, and which have also been perused by Professor Malmgren. But even with this small amount of material, I feel confident that I can show conclusively that Professor Malmgren is exceedingly unjust in speaking disparagingly of artificial fish-culture and its results. Following, with some slight deviations, the order in which Professor Malmgren speaks of the different countries, I shall begin with France, which, in 1850 and the following years, gave a new impetus to artificial fish-culture.

FRANCE.

Professor Malmgren, referring to the review of the history of artificial fish-culture in France, contained in Blanchard's work "*Les poissons des eaux douces de la France*" ["Freshwater Fish of France"], (Paris, 1866), remarks that the sudden interest in fish-culture which had been awakened about 1850 had, after many disappointments, already almost died out prior to 1870; and in this opinion I must entirely agree with him. But when he attempts to use this fact in depreciating artificial fish-culture in general, he proves himself prejudiced and insufficiently informed.

There are two reasons why artificial fish-culture in France did not realize the hopes, which it must be confessed were of the most extravagant kind, entertained by many Frenchmen.

The first is the spring water theory. Nurtured by mere book-learning, this theory became the Alpha and Omega of the artificial culture of the salmonoids, which was at that time aimed at almost exclusively. It was thought that keeping the hatching water at as even a temperature as possible was an essential condition for the development of the eggs and young fish. Hence the endeavors to obtain the spring water as near its source as possible, and to carry it through tubes or pipes, so it might not lose any of its warmth. The evils resulting from this spring water theory I have already referred to above, under the head of Russia. The great Government establishment at Huningen was the representative and advocate of this theory; and in this respect it has exercised a positively hurtful influence on the development of artificial fish-culture, not only in France, but also in other countries. We would be able to chronicle far greater results if fish-culture had not for twenty years, 1850 to 1870, been absolutely governed by this spring water theory. How were matters managed in Huningen during this period? Towards the end of December, at the latest during the first days in January, the shipping of the winter fish-eggs, which had been impregnated so as to become visible to the naked eye, was generally finished.* As the persons to whom these eggs were shipped followed the example of Huningen and also operated with spring water, the young fish which were raised had generally lost their umbilical sacs about the middle of February, and had either to be placed in open waters, or to be fed artificially in the various establishments. The difficulties arising from this method have already been mentioned under the head of Russia. It is therefore by no means a matter of surprise that many of the fish raised in this unnatural manner perished, and that no results of any importance could be chronicled.

The second cause why fish-culture in France did not make sufficient

* After Huningen passed into the possession of Germany strong endeavors have been made to remedy these evils, and during late years great progress has been made in this direction.

progress must be sought in the fact that much time and energy was wasted in most unpractical experiments by attempting to raise valuable fish according to methods totally opposed to their mode of life. Thus, attempts were made to raise salmon (*Salmo salar*), sea trout (*Trutta trutta*), and lake trout (*Trutta lacustris*) in ponds. These experiments, of course, proved unsuccessful, and people began to lose faith in fish-culture. Any one who wishes to acquaint himself with this subject should read Blanchard, and he will get a very clear idea of French fish-culture, which never got beyond mere dilettantism. Only in exceptional cases were moderate results obtained in the raising of brook trout.

In stating that up to 1862 the Huningen establishment had cost the Government 600,000 francs [$115,800] without being able to show corresponding results, Professor Malmgren forgets that Huningen distributed all eggs gratuitously, and therefore derived no income from this source; while the expenses for procuring fish-spawn were very considerable. While in the possession of France, Huningen was an expensive institution; it supported numerous agents, and paid high prices for eggs, all of which cost considerable sums. When Professor Malmgren lays special stress on the fact that, during the period of 1855 to 1862 about 30,000,000 salmon eggs were impregnated in Huningen, I must confess that I do not consider this an unusually high figure, for it would only be about 3,500,000 per annum. If we consider that France (not counting in her colonies) was at that time a country with an area of 207,480 square miles, and a population of 38,030,000, the quantity of eggs given above is by no means very large, especially in view of the great liberality of the French Government which gratuitously sent to foreign countries large quantities of eggs. All these facts seem to have been overlooked by Professor Malmgren.

In spite of all the disappointments to which France was doomed, Blanchard, from whose above-mentioned work Dr. Malmgren derives his information, is by no means positively opposed to artificial fish-culture; all he desires is, as he states on pp. 610–623 of his work accompanying (in translation) Dr. Malmgren's report to the Senate, that fish-culture should be carried on in a rational manner, and particularly that fish should not be raised in a way totally different from their accustomed mode of life, and that, under all circumstances, fish should be placed in waters where they find a sufficient quantity of wholesome food. In short, Blanchard wants the right fish in the right water. He also wishes the law to protect the waters from pollution, and desires fish-ways to aid the ascent of the migratory fish. That France, in spite of numerous failures, has not finally abandoned artificial fish-culture will be seen from the fact that she has, at Government expense, founded a new establishment at Epinal, in the Vosges Mountains, which operates with river water and seems to obtain good results. (See article by Meyer: "*Ein Besuch der neuen franzosischen Fischzuchtanstalt bei Epinal*," in *Deutsche Fischerei-Zeitung*, 1883, pp. 164 and 180.)

GERMANY.

I now turn to Germany and shall here pay special attention to the results of salmon-culture, because it is aided by Government subsidies, and because it is the principal field of activity of the German Fishery Association, of which Professor Malmgren speaks so unfavorably. Moreover we possess more material relative to salmon-culture, while the results obtained by private efforts, which have principally been devoted to the cultivation of the brook trout, have become but little known. I shall begin with the waters in the eastern part of Germany and gradually proceed toward the west.

In the Courland Sea and the inland waters of East Prussia the salmon fisheries had considerably declined about the year 1870. As Beerbohm states in his *Die Fischerei des Kurischen Haffs und der Nebengewässer* (the fisheries of the Courland Sea and adjacent waters), the salmon fisheries in these waters had almost come to an end about that time, simply owing to the lack of fish. Throughout the whole of East and West Prussia a similar decline of the salmon fisheries was reported. The fishery association of these two provinces has made the furtherance of their fisheries its special object, and in its efforts has been aided by the Government and the German Fishery Association. From small beginnings it has risen slowly but steadily, and, thanks to the indefatigable activity of Professor Benecke, of Königsberg, is constantly spreading a greater interest in the fisheries among the general public of East and West Prussia. As regards the efforts of this association in the line of salmon-culture, we must state that young salmon fry were first placed in the waters of East Prussia in 1877, circumstances, however, not permitting operations on a large scale. During last winter about 300,000 salmon eggs were hatched in East Prussia, assuredly no insignificant quantity. Also in West Prussia, near Elbing and Marienwerder, and in the river Rhede, near Danzig, young salmon fry have been placed in the water, though only in small quantities.

Nor can we pass by in silence the placing of young salmon fry in waters in the region of the Upper Vistula in Galicia, through the aid of the German Fishery Association, and the energetic efforts of Professor Novicki in Cracow. Including the year 1883, a total of 361,000 young salmon have been placed in Galician waters, a quantity which, considering the extent of the Vistula region, cannot be called very great.

As a result of these efforts made both in East and West Prussia and in the Upper Vistula region, we must doubtless consider the appearance, during the last few years, of enormous numbers of young salmon along the entire coast of Prussia from Hela to Memel. Many wagon-loads of these fish have been brought to market, unfortunately among them fish measuring from 20 to 30 centimeters [8 to 12 inches] in length. We may, therefore, hope that the salmon fisheries will increase considerably,

both in the inland waters of East and West Prussia and in the region of the Vistula.

A striking illustration of the success of artificial salmon-culture is furnished by the small coast river Rhede, flowing into the bay of Putzig, north of Danzig. In the autumn of 1871, 2,100 nine-months'-old salmon were, at the expense of the Government, furnished by the hatchery of Prince Wied, at Aubach, near Neuwied, and I was commissioned by the German Fishery Association to take them in charge. There were placed in the river Rhede 1,600 of these fish, and the remainder were sent to Stolpe in Pomerania. Mr. Muller, of Tschischdorf, successfully conveyed these fish to their destination, and they were placed in the Rhede, from which the salmon had entirely disappeared. In July, 1875, numerous salmon, measuring about 50 centimeters [20 inches] in length, ascended the river from the sea, evidently some of the fish which we had placed in these waters four years ago (German Fishery Association, 1876, p. 158). The hatchery founded in Oliva by the chief forester, Mr. Liebeneiner, has, since 1874, continued to stock the Rhede with young salmon (8,000 in 1874, and 31,000 in 1876). Gradually the Rhede salmon fisheries increased in importance; thus, during the season of 1879-'80 a much larger number of salmon were caught than during the preceding season (German Fishery Association, 1880, p. 103). As Mr. Liebeneiner says in his report for 1880-'81, the salmon fisheries in the waters near the mouth of the Vistula and in the bay of Putzig have increased very considerably, but it is difficult to obtain an exact estimate of the result of these fisheries, as the fishermen endeavor to keep it secret. It is a fact, however, that many hundred-weights of salmon have been shipped from the stations of Rhede, Kielaw, and Zappot.

The Fishery Association of East and West Prussia has also given some attention to the raising of *Coregonus*, although, so far, with one exception to which we refer below, without much success, in spite of the fact that, since 1879, very considerable quantities of young *Coregonus* have been placed in different waters. It is true that recently some *Coregonus* have been caught in various lakes, but only occasionally and in small numbers. (As I have done under the head of Russia, I would also advise in East Prussia greater care of the *Coregonus*, especially during the spawning season.) The raising of *Coregonus lavaretus* has also met with numerous failures, although we are happy in being able to chronicle at least one good result, in the bay of Putzig. After about 20,000 young fish of this kind had, in 1879, been placed in a brook near Oliva, quite a number of these fish were, during the following years, observed in various parts of the bay of Putzig, and in the autumn of 1882 a larger number of these fish were caught than had been the case for a long time. (Report of the Fishery Association of East and West Prussia for 1882-'83, p. 27.)

Professor Benecke, of Köningsberg (Circular of German Fishery As-

sociation, 1881, p. 150), also reports that large *maräne* have been found in the Raygrod Lake (southeast of Lyck), belonging partly to Prussia and partly to Russia, while formerly they did not occur there. After a few such fish had been caught in that lake during the winters of 1879–'80, quite a large number were caught in 1880–'81. During the following years large *maräne* have often been caught there. It has been impossible, however, to obtain more information on the subject, as the persons who rent the fisheries have an interest in keeping the results secret, the fish being quietly shipped to Poland. It is probable that these *maräne* came from the neighboring Russian fish-cultural establishment of Suwalki, where the *maräne* of the Ladoga and Peipus Lakes has been cultivated for many years. These facts speak strongly in favor of the success of Russian fish-culture, as no fry of that fish have been planted in this lake on the Prussian side.

I now come to the region of the Oder River, a review of whose salmon culture I gave in Nos. 28 and 29, Vol. VI of *Deutsche Fischerei-Zeitung*, so that here I may confine myself to the following statement: Starting from a small beginning in 1868–'69, the enterprise gradually assumed larger dimensions. Up to 1879 the largest number of salmon-eggs hatched in one year was 365,000 (in the winter of 1871–'72). Since 1871 there has been a noticeable increase of salmon off the mouth of the Dievenow, the eastern channel connecting the Great Haff with the Baltic Sea, although prior to that year the salmon fisheries of this region had declined so much that many fishermen emigrated to Eastern Pomerania. From 1871 the salmon fisheries off the mouth of the Dievenow increased from year to year till (according to statements furnished by the fishermen) the spring fisheries alone yielded 45,212 pounds in 1875, and 52,293 pounds in 1876. Owing to a combination of different unfavorable circumstances the yield was not so good during the following year. In the early part of the summer of 1880 so many young salmon were caught that many of them could not be sold as food, but had to be used as manure. Since 1877 the salmon also increased considerably off the mouth of the Swine and Peene. Also, in the present year (1883) a large number of salmon have been caught on the coast of Pomerania (*Deutsche Fisherei-Zeitung*, 1883, p. 293), which undoubtedly is owing to the planting of young salmon fry further up the Oder and in some of its tributaries.

Although the salmon-culture of the Oder region has borne rich fruit in the sea outside the mouth of the Oder, the same cannot be said of the entire valley of the Oder. The salmon seemed principally to go into the rivers Warthe and Netze, where these fish, which had become rare in these rivers, again made their appearance in large numbers since 1874. Thus in 1873 at Landsberg, Driesen, and Steinbusch, respectively, 9, 9, and 6 salmon were caught; while in 1875 in the same localities there were caught 205, 154, and 120 large fish. During the following years the salmon fisheries were not so productive, owing to unfavorable

conditions of water and temperature; in the autumn of 1882, however, 94 salmon were caught at Steinbusch. If, in spite of these facts, the salmon visit the Upper Oder irregularly, the reason must be found in the condition of the sandy bed of the river.

On the Mecklenburg coast formerly from 80 to 100 salmon were caught per annum; but since the fish-cultural establishment of Schwerin (under the superintendence of Mr. Brüssow) has planted young salmon and sea trout in the open waters, the annual yield of the Mecklenberg fisheries has been about 2,000, and in 1882 these were principally young fish weighing from 3 to 8 pounds apiece. Very remarkable results can be chronicled for the Darssow Inlet. After the Schwerin establishment had, in 1870–'71, commenced to plant young fry in the river Stepenitz, many salmon have been caught in the Darssow Inlet, a fact which the fishermen at first attempted to keep secret. Very good sea-trout fisheries have sprung up on the coast near Doberan, the fish weighing from 1 to 2 pounds, since the Schwerin establishment began to plant most of its young fry in the Doberan stream near Wismar. (See *Deutsche Fischerei-Zeitung*, 1882, pp. 170 and 171; 1883, p. 18; also, Von dem Borne's "*Fischerei-Verhältnisse des Deutschen Reiches*," &c., Berlin, 1860, p. 83.)

Since 1860 the river Trave has been stocked with young salmon from the piscicultural establishment at Lubeck, and the experiment has proved very successful. Besides the blue-backed salmon there were also found silver-colored Rhine salmon, as eggs of both kinds had been hatched. At one haul 800 pounds of Rhine salmon were caught near the mouth of the Trave. (See Circular 1 of the German Fishery Association, 1871, p. 90, and Fritsche's "*Die Flussfischerei in Böhmen*," Prague, 1871, p. 45.) The Trave salmon fisheries developed still further, after (since 1872) the fish-cultural establishment of Gremsmuhlen, near Eutin, (under the superintendence of Mr. Bruhns) began to plant salmon fry in the river Schwarzau, which flows into the Trave. In 1878 the Haffkrug fishermen caught 2,000 pounds of salmon, a larger quantity than had hitherto been taken here. In 1879 the fishermen of Niendorf, Schaarbeck, Haffkrug, and Sierksdorf caught 6,400 pounds of salmon during the period from the beginning of April till the 25th of April. Unfortunately we have no data respecting the Schlutup and Travemunde fisheries, where likewise many salmon were caught. (Report by Mr. Bruhns in Circular of the German Fishery Association, 1879, p. 69, and 1881, p. 148.)

I now come to the river Weser, whose salmon-culture I have already spoken of in the current volume (Vol. VI) of the *Deutsche Fischerei-Zeitung*, p. 182. The salmon fisheries near Hameln, where these fish meet their first hinderance in ascending the stream in the shape of a large weir, furnish a good basis for judging the results of artificial salmon-culture. After the Hameln town council had taken an interest in the matter, and had established a salmon hatchery, which was placed in charge of Mr. Schieber, the planting of salmon fry was begun in

1858. In that year 80,000 were planted; in 1859 and 1860, 30,000; none in 1861, 1862, and 1863; and from 1864 to 1866 a quantity varying between 28,000 and 39,000 per annum. After another interval of two years, the number planted annually from 1869 to 1874 varied between 10,000 and 45,000. As regards the following years I have no data.

To give an idea of the results obtained, I shall first give an example from the so-called "good old times." From a report for the year 1713, it appears that in that year there were caught near Hameln, all in all, 245 salmon, weighing 2,019½ pounds. (See Circular of the German Fishery Association, 1880, p. 69.) After the planting of young fry, referred to above, the Hameln salmon fisheries increased in a wonderful manner, the number of salmon being noticeably less in those years when no young fry were planted. There were caught, in 1862, 2,600 salmon; in 1863, 4,000; 1864, 5,000; 1865, 1,500; 1866, 1,100; 1867, 900; 1868, 1,500; 1869, 1,800; 1870, 2,000; 1871, 600; 1872, 2,200; 1873, 1,000; 1874, 7,500; 1876, 2,300; 1877, 1,870; 1878, 1,200; 1879, 487; 1880, 1,250. The statistics of the last two years, however, do not comprise the number of fish caught near Wehrbergen and Lachem. For the years 1881, 1882, and 1883, I possess no data.

The annual rent for the salmon fisheries near the Hameln weir was, in 1856, only 1,830 marks [$439]; it rose to 12,000 marks [$2,856] for the three-years' period of 1866 to 1868; declined to 5,537 marks [$1,317.80] and 4,665 marks [$1,090.27] in 1869 and 1874, respectively; rising again to 15,285 marks [$3,637.83] for the period from 1875 to 1879; and was 15,660 marks [$3,731.08] in 1877–'79; and 10,005 marks [$2,381.19] in 1880. The Hude salmon fisheries, below the weir, the private property of some citizens of Hameln, rented for 18 marks [$4.28] in 1846, later for 300 marks [$71.40], and for 4,560 marks [$1,086.28] during the period from 1877 to 1880. These figures certainly prove the success of salmon planting in the Weser. In Hameln we find the very rare instance of fisheries whose results do not shun publicity, because the fisheries are rented to joint-stock companies whose shareholders demand full and accurate statements.

Above Hameln, also, the salmon fisheries show a large number of fish, compared with previous years, whenever the condition of the river enabled the fish to pass the weir referred to above. Thus, in the autumn of 1865, the Fulda salmon fisheries were so productive that a pound of salmon sold for 30 pfennige [about 7 cents]. Mr. Schieber, of Hameln, caught 65 salmon from the 5th to the 8th of November, near Daub's Mill, on the river Eder, a tributary of the Fulda (see Circular of the German Fishery Association, 1872, p. 195). Of late years the Fishery Association of the district of Kassel has also taken up salmon-culture, and plants salmon fry in the waters of that district, so that we may look for still further development of the salmon fisheries.

If during the last few years the Hameln salmon fisheries have been less productive, the reason therefor must be found in unfavorable

conditions of the water and the weather, and also in the fact that numerous salmon fisheries are now carried on also in the Weser below Hameln. Preuss says, in an article published in the *Weser-Zeitung* in 1874, and reprinted in the circulars of the German Fishery Association, 1874, pp. 74 *et seq.*, entitled "Fish and Fisheries of the Lower Weser," that the salmon fisheries had reached their lowest ebb; in that year a single large salmon (weighing 25 pounds) had been caught near Kaseburg, while smaller fish, weighing from 1 to 2 pounds (here we recognize the results of the Hameln establishment) were more frequent. About the year 1879 the salmon fisheries of the Lower Weser began to increase very perceptibly. In 1879–'80 an unusual number of salmon, weighing from 3½ to 5 pounds, were observed near Stolzenau, and in 1880–'81 extraordinarily large quantities of salmon were caught. It deserves to be mentioned that at that time, even during the most successful fishing season, nearly all the fish caught weighed 9 or 10 pounds, a uniformity which had never been observed before, and which also points to the planting of artificially-hatched fry farther up the river. (See "Report by Mr. Kleinschmidt, of Stolzenau," in Circulars of the German Fishery Association, 1878, p. 147.)

The salmon fisheries of the Lower Weser, which formerly had hardly amounted to anything, began to develop rapidly, and new fisheries were started. On the river banks from Oslebshausen (1½ German miles [6 or 7 English miles] below Bremen), as far as the Baden Hills (2½ German miles above Bremen), there are now said to be 16 or 17 salmon fisheries. In Bremen itself four different fishery associations are engaged in the salmon fisheries (*Deutsche Fischerei-Zeitung*, 1883, p. 35). Although some of the Bremen salmon fisheries are not favorably located, the Lower Weser has nevertheless, of late years, yielded a considerable number of salmon. In February, 1882, for instance, so many Weser salmon were brought into the Geestemunde market that they were sold at 1 mark 70 pfennige [40 cents] per pound. In the spring of 1883 the salmon fisheries of the Lower Weser were still more productive. In view of these circumstances, it is not surprising that the Hameln salmon fisheries do not always yield as good results as in former times, when there were but few such fisheries on the Lower Weser.

The territory of the River Ems, where the salmon fisheries had also declined, and, properly speaking, have, with few exceptions, never amounted to much, has since 1878 been stocked with young salmon on a large scale by the German Fishery Association. A small beginning in that direction had been made in 1872 and 1874, when 17,000 young salmon were planted. As to the results, I have but very few and imperfect data, as many portions of this territory are but sparsely populated, and but little attention is given to the salmon fisheries and their statistics.

Near Quakenbruck there were exceptionally successful salmon fish-

eries in the autumn of 1874, while during the following years, they were poor. The successful fisheries of the year 1874 may possibly be traced to the planting of young salmon in 1872, for the male salmon often leave the sea and ascend the rivers in their third year. In the autumn of 1881 a considerable number of salmon were observed at the Haneckenfahr weir (which has a salmon-way) above Lingen. In the Hopster River (*i. e.*, in its lower portion) there were caught, in 1880, 9 salmon; in 1881, 62; and in 1882, inclusive of those caught in the lower portion of the Voltlager stream (a tributary of the Hopster River), about 500 pounds. The Quakenbruck salmon fisheries in the river Haase, in 1880, yielded 20 salmon; in 1881, 50; and in 1882 (including some fish caught in the Wran, a tributary of the Haase), 900 pounds.

Near Friesaythe (Oldenburg) the annual yield of the salmon fisheries was, under favorable circumstances, about 40 fish; while in the autumn of 1882, although the fisheries could only be carried on for eight days, owing to the high water, 30 salmon, weighing on an average 10 pounds apiece, were caught during that short time, from which we may draw the conclusion that a larger number of salmon than usual came that way.

I must not forget to notice that a number of salmon made their appearance in the river Werse (a tributary of the Ems), near Munster, where I planted young salmon in 1878. Favored by the high water, a number of salmon coming from the sea crossed the weir in the Ems near Rheine and ascended the Werse, where, in the beginning of July, 1882, salmon very unexpectedly made their appearance near the Havichhorst Mills. Owing to the lack of the necessary fishing apparatus, only a few could be caught; but when the water had again become clear some 20 salmon could be observed in front of the mill-dam. Even the oldest inhabitants could not recollect ever having seen salmon in that neighborhood. (See Circulars of the German Fishery Association, 1882, pp. 129 and 130; 1883, p. 15.) In July, 1883, some more salmon were seen in the Werse, and both in its lower portion, as well as in the Ems, near the place where the Werse flows into it, many such fish have been observed, as is stated in the official reports.

I now come to the Rhine, one of our most important salmon rivers, and my observations will of course also embrace the Netherlands, where the Rhine flows into the sea.

When the French Government was still in possession of Huningen, it took great trouble to introduce young salmon in the Rhine valley, and since 1870 Germany and Switzerland have continued to plant young salmon. During the period from 1879 to 1881, young salmon from Huningen have also been planted on French territory near the sources of the Moselle, near Epinal, &c. The Netherlands have also followed the example set by Germany, and the Dutch Government pays rewards for the planting of young salmon.

The largest share of the Rhine salmon fisheries at present belongs

to the Netherlands, which country makes the very best use of her natural advantages. The Dutch catch a very large quantity of salmon; and even in poor years the monthly yield of their salmon fisheries is estimated at about 10,000 fish (*Deutsche Fischerei-Zeitung*, 1880, p. 269). The success of the salmon fisheries in the Rhine valley, from the Dutch-German frontier, mainly depends on high water in the Netherlands at the seasons when the salmon ascend the river, and when the Dutch fisheries either come to a close or are only carried on in a desultory manner. Unsuccessful German and Swiss salmon fisheries (as those of 1879 and 1880), even when the conditions of water and weather are not entirely unfavorable, must not lead us to the conclusion that the planting of young salmon in the German portion of the Rhine valley has been a failure. Thus, Mr. Bieler, of Basel, reports, in 1880, that for the last three years there had been more *sälmling* (salmon which have not yet been to sea) in the Rhine, than the oldest fishermen could recollect (*Deutsche Fischerei-Zeitung*, 1880, p. 411). Not to trace such facts to the planting of artificially-hatched young salmon is sheer obstinacy in spite of better knowledge. If we could get reliable and full reports on the Dutch salmon fisheries, conclusive proof could doubtless be furnished of the good results of the planting of young salmon in the middle and upper valley of the Rhine. Unfortunately this has, so far, not been possible. The statistics of the salmon brought to the Kralingsche Veer (the largest Dutch fishmarket) do not give us the full figures, because the dealers often buy their fish direct from the fishermen. The number of fish brought to the Kralingsche Veer by the fisherman has also decreased, owing to the fact that all fish brought to that market have to pay a tax of 5 per cent of their value. While in 1863 35,300 salmon were brought to the Kralingsche Veer, the number in 1869 was only 15,500, which decrease, under the existing circumstances, can by no means be construed into a decline of the Dutch salmon fisheries. (See Mr. Quakernaat's Dutch report, in Circulars of the German Fishery Association, 1871, I, p. 24.) During the period from 1870 to 1880 the largest number of salmon brought to the Kralingsche Veer in a year was 77,070 (in 1874), and the smallest 21,687 (in 1870). (See Circulars of the German Fishery Association, 1881, p. 148.)

In view of the Dutch robbery-system of fisheries, we may well maintain that, if Germany and Switzerland did not annually plant large quantities of young salmon, the Dutch fisheries would not long continue as successful as they are at present. Such rich fisheries cannot merely be the result of natural spawning, for on the Upper Rhine the waters in which the salmon find suitable spawning places are anything but numerous. To become convinced of this, one has only to see the rivers and streams which in Baden flow from the Black Forest into the Rhine, and which in their lower and middle course have generally been subjected to so many improvements that it would be hard for the salmon to find a spawning place; numerous weirs, moreover, hinder the

salmon from reaching the upper and more favorable portions of these tributaries of the Rhine. If Germany and Switzerland were for a number of years to cease planting salmon fry in the Rhine valley, the results of the Dutch salmon fisheries would soon undergo a change, and the Dutch might be induced to carry on their fisheries in a more reasonable way. But, as it is, we go on planting salmon fry from year to year and only reap those fruits of our trouble which mere accidents procure for us.

That in spite of this, and in spite of unfavorable years, the salmon fisheries on the Upper Rhine have, on the whole, progressed, will be seen from the rent paid for the salmon fisheries near Badish and Swiss Laufenburg. In 1860 the rent was 4,000 francs [$772]; in 1866, 8,000 francs [$1,544]; in 1872, 17,000 francs [$3,011]; in 1878, 23,600 francs [$4,554.80]; and in 1880, 30,500 francs [$5,886.50]. (See Circulars of the German Fishery Association, 1882, p. 170.)

A remarkable proof of the success of planting young salmon was furnished in the river Kyll, flowing into the river Moselle below Treves, where many years ago salmon had become a great rarity. After I had in 1876 planted salmon fry in this river, by commission of the German Fishery Association, the first salmon made their appearance in the Kyll in the autumn of 1879, when about 30 were caught near Ehrang, while in the autumn of 1880 the number rose to 150. We should not fail to mention that the fish which were caught in the Kyll, in order to reach that river, had to clear the weir at the junction of that river with the Moselle, which they were enabled to do at certain times by the unusually high water. Many of the salmon, however, will have found it impossible to do this, and they would remain in the Moselle and become the prey of the fishermen of that river. The good salmon fisheries in the Lower Kyll in the autumn of 1880 lowered the price of salmon in that part of the country to 50 pfennige [11½ cents] per pound. As regards the following years I have no statistics.

Of late years the Fishery Association of the rivers Ruhr and Lenne, at Menden, in Westphalia, has begun to plant salmon fry, and already good results are apparent, especially since the murderous trap at Broich was abolished. Whenever the condition of the water is any way favorable, numerous salmon make their appearance in front of the weir in the river Ruhr, near Witten, and some of them even go as far as Arnsberg, a thing which did not happen before for a great many years.

Another, though not such a striking, example of the success of artificial salmon-culture was furnished last winter at Freiburg, in Baden, when, favored by the high water, a number of salmon ascended the river Dreisam as far as the city of Freiburg, no doubt as a result of the planting of salmon fry farther up the river some years previous. The oldest people at Freiburg do not recollect ever having seen salmon before in that part of the Dreisam. During ten days about 100 pounds of salmon were caught, all young male fish, with the exception of an

old female, weighing on an average 5 pounds. These salmon were caught only with the view to get eggs for artificial hatching; if the salmon fisheries at that time had not been closed for others on account of the season of prohibition, they would, although somewhat hindered by the high water, have yielded still better results. In the Danube, where formerly there were no migratory salmon, the German Fishery Association has, in the upper parts of the river, for some years planted fry of Rhine and California salmon. The results of these plantings have not yet appeared.

From this brief review it will be sufficiently evident that the efforts of the German Fishery Association have not been in vain, but have, in many instances, been crowned with remarkable success. In spite of this, Professor Malmgren thinks that the German Fishery Association has lost the confidence of the Government, for, on p. 14 of his pamphlet, he says: "It is a very noteworthy fact that the German Government, which hitherto has specially favored the enterprises of the German Fishery Association, and which very materially aided the Berlin Exposition of 1880, which had been planned by that association, last year refused even the smallest appropriation to enable Germany to be represented at the International Fisheries Exhibition in London, in consequence of which the association has been compelled to abandon its idea of participating in that exhibition."

Any one who can read between the lines will readily see that Professor Malmgren thereby means to intimate that the German Fishery Association, whose work had been in vain, had lost the confidence of the German Government, as was shown by its refusal to grant an appropriation. Professor Malmgren may rest assured that the refusal of the appropriation was not owing to this cause. Before the president of the association made the request of the Government he asked a number of the members for their opinion on the subject. I was also asked for my opinion, and I do not hesitate to give once more the views expressed by me at the time. I thought it my duty to call attention to the fact that England, although occupying a very prominent position among the nations engaged in fisheries, refused to participate officially in the Berlin Exposition. Only a few firms engaged in the manufacture of fishing tackle had made an exhibit, and besides these, if I remember right, a few private individuals had exhibited a few insignificant articles. Every visitor to the Berlin Exposition will remember the scantiness of the English department. Even the Chinese had shown more sympathy with our efforts than proud Britain, which looks with envy upon our great national uprising, dating from 1871. After Germany had sufficiently shown at the Berlin Exposition what it can do in the matter of fisheries, and as we, after England's action in 1880, did not feel under any special obligations towards that country, my opinion was that, under the circumstances, it would be best for Germany not to be officially represented at the London Exhibition, all the more as a considerable

sum would have been required to do this in a manner worthy of our country. I believe that many other persons entertained the same views. If the president of the German Fishery Association asked the German Government for an appropriation, it was a step dictated by simple politeness. The Government did not comply with the request, because it thought that no special advantage could be derived from our being represented at the London Exhibition. The president of the German Fishery Association has not been painfully disappointed thereby, nor has the German Government by its action intended to express any displeasure with the association, for, at the instance of the Government, a number of prominent members of the association were sent to London in order to report on the exhibition. These reports are to be published by the German Fishery Association, for which purpose the Government has granted an appropriation.

AUSTRIA.

In this country artificial fish-culture has also, during the last ten years or more, made good progress. Very remarkable results have been obtained in Bohemia as regards the salmon-culture of the valley of the Elbe, and this at a very trifling expense, as has already been stated under the head of Germany. Young salmon have also, during the last few years, been planted in the territory of the Upper Vistula, but so far no results can be recorded. Austria has more especially devoted her efforts in artificial fish-culture to the various kinds of trout, and, as I have been informed, very satisfactory results have been obtained by private individuals.

If Professor Malmgren endeavors to find some connection between the closing of the Salzburg establishment (founded in 1865) and the decline of artificial fish-culture, he certainly labors under a mistake. It is true that Professor Malmgren mentions the article on the Salzburg establishment, by M. Schrayer (*Deutsche Fischerei-Zeitung*, 1882, p. 151), but without quoting those passages which show its defects. Schrayer states expressly that the Salzburg establishment was by no means a model institution, but that it suffered from a combination of unfortunate circumstances. The two branch institutions of Seekirchner and Hintersee, although in a good condition, were not able to save the main establishment. As early as 1871 I learned from very good authority that the establishment rested on an unsound basis, and would sooner or later have to be closed. Why does Professor Malmgren pass these facts in silence, although he must certainly have been acquainted with them from Schrayer's article?

ENGLAND.

Professor Malmgren questions whether artificial fish-culture has met with any success in England, and ascribes the increase in the number of fish to the strict observance of the seasons of prohibition. People

in England, however, feel convinced that artificial fish-culture has contributed its share towards the development of the salmon fisheries, of course aided by the strict prohibitory measures, to which our German fishermen object so much. It is beyond a doubt that the large salmon-cultural establishment at Stormontfield has greatly promoted the Tay salmon fisheries. I possess no extended information relative to the English fisheries, but I have been told recently that in July, 1883, the Scotch salmon fisheries were exceptionally productive, especially near Carloway, Loch Resort, Uig, and Kean. One hundred salmon have been caught there at a single haul, weighing from 10 to 30 pounds apiece. In consequence of these rich fisheries the price of salmon fell to 6 pence per pound. At the same time great quantities of salmon were observed near the Lewis Islands. People there are generally convinced that these results are due to artificial salmon-culture in connection with the prohibitory measures (*Deutsche Fischerei-Zeitung*, 1883, p. 279). As far as I can learn, people in England are likewise satisfied with the results of artificial trout-culture, and during his visit to the London Exhibition, Professor Malmgren might have learned that people in England do not share his gloomy views regarding artificial fish-culture in general.

A very encouraging fact is mentioned regarding Loch Leven; one hundred years ago the income from the fisheries in that lake did not amount to more than £700 per annum, while now, thanks to artificial fish-culture, it is upwards of £3,000 [$15,000]. As an instance of the way in which even comparatively poor fishermen are benefited by artificial fish-culture, we may mention the fishermen of Costa (Yorkshire), who annually plant from 12,000 to 14,000 trout fry in their waters and obtain very good results. (See report by Raveret Wattel in Circulars of the German Fishery Association, 1882, p. 65.) The number of fishery associations in England is very great. Unfortunately the English waters, in spite of all prohibitory measures, suffer frequently from the injurious influences of manufactures, and artificial fish-culture will doubtless do its share towards remedying this evil.

SWEDEN.

The great activity in the field of artificial fish-culture which we find in Sweden, is, according to Professor Malmgren, without any result as regards the increase of fish in the open waters. He mentions, among the rest, the closing by the Government of the normal fish-cultural establishment of Ostanbeck, after it had been in existence for eighteen years. I do not know what circumstances have brought about this result, but it seems to me a forced conclusion to consider it, as Professor Malmgren does, as an indication of the decline of artificial fish-culture in Sweden, especially if we consider the undoubted results of artificial fish-culture in other parts of that country.

Before I give any instances I must once more refer to the difficulties

already mentioned under the head of Russia, under which fish-culture labors in the North of Europe, owing to the spring-water theory. If fish-culture in Sweden had not to suffer from these difficulties it would undoubtedly be able to show much greater results. Mr. von Yhlen, the Swedish inspector of fisheries, discussed this whole question some years ago in an article on "salmon-culture in Sweden" (*Deutsche Fischerei-Zeitung*, 1880, pp. 130, 189, and 214), and has recommended the use of ice for cooling the spring water.

In spite of this, artificial salmon-culture in Sweden has not been a vain labor, as Professor Malmgren seems to think it has. Although the data in my possession are very scanty, they nevertheless show some remarkable instances of the success of salmon-culture. According to the official report, Sweden, in 1883, had 60 fish-cultural establishments, mostly engaged in salmon-culture (*Deutsche Fischerei-Zeitung*, 1883, p. 45). The following data will show that, on the whole, the labor of these establishments has not been in vain. In 1870 the Nissa River, which flows into the Cattegat near Halmstad, did not contain a single salmon. After it had been stocked with salmon fry, 25,000 pounds of salmon were caught in 1878, a result which, in Sweden, is traced directly to fish-culture. (See *Deutsche Fischerei-Zeitung*, 1878, p. 355.)

Salmon-culture is also carried on on the Laga River (which flows into the Cattegat south of the Nissa). The salmon fisheries in that river had steadily increased for several years, and in the autumn of 1881 such an extraordinarily large number of salmon was observed that, near Karsefors, they actually filled the river from bank to bank. (See *Deutsche Fischerei-Zeitung*, 1882, p. 237.)

On the Ljusne River, which flows into the Gulf of Bothnia, and which possesses several salmon-cultural establishments, the salmon fisheries are exceedingly productive. Near Ljusne, where the principal salmon-fisheries are carried on, there were caught, in 1881, 3,432 salmon, weighing 67,160 pounds, and valued at 30,481 crowns [$8,168.90]; and this result is considered as entirely due to the fact that salmon fry have been repeatedly planted in the Ljusne River.

Near Carlstad, on the Wener Lake, the salmon fisheries became unusually productive towards the middle of June, 1883, from 400 to 500 salmon being brought to market every day (*Deutsche Fischerei-Zeitung*, 1883, p. 219). Are we not justified in ascribing this to the results of salmon-culture on the Klar River, which flows into the Wener Lake?

NORWAY.

The reports on artificial fish-culture in Norway, and especially on salmon-culture, are somewhat contradictory; but, on the whole, the results do not appear to have been very satisfactory.

As Professor Malmgren shows from official documents, 240 private fish-cultural establishments have been started in Norway since 1856, the majority of which were engaged in the culture of trout, *salbling*, and

marine, while only about one-third devoted themselves to salmon-culture. The greater number of these establishments have been closed in course of time, owing to the unsatisfactory results, so that in 1878–'79 only 38 were in existence, 16 of which were engaged in salmon-culture. Most of these 38 establishments are very small, only 5 reaching an annual production of 100,000 young fish. Although for a long time 1,000,000 to 1,500,000 salmon fry have annually been planted, no certain proof can be furnished—as Mr. Landmark, inspector of fisheries, states in his report for 1881—that artificial fish-culture has been in any way a benefit to the Norwegian salmon fisheries, which on the contrary seem to have declined.

As Director Haack says in the Official Reports on the International Fishery Exposition at Berlin, 1880, in the chapter on fish-culture (p. 37), salmon-culture in Norway was carried on in 50 rivers, as he was orally informed by Mr. Wallem, the Norwegian commissioner. Although this culture is not carried on extensively, the salmon fisheries, formerly on the decline, are said to increase slowly but steadily.

A report from Christiania, published in the *Deutsche Fischerei-Zeitung*, 1882, p. 28, describes the Norwegian salmon fisheries in 1881 as on the whole satisfactory. In the northern districts these fisheries were not so productive as formerly, but along the entire southern coast, from Arendal to Namsoe, both in the sea and in the rivers, it was better than during the preceding years. In spite of this the report says that it cannot be denied that the salmon fisheries are on the decline, and the cause of this is thought to be the very lax way in which the prohibitory measures are observed.

It appears from the above that the condition of affairs in Norway leaves much to be desired. I have not been able to obtain any further information as to the causes of the closing of so many fish-cultural establishments, but I am inclined to believe that one of the principal causes is the spring-water theory, to which I have already referred under the heads of Russia and Sweden. This method will secure only insignificant results, and be the source of many disappointments. It should, moreover, be taken into consideration that salmon-culture in Norway is only managed on a small scale by the various establishments, and doubtless with considerable loss. If, in addition to this, the prohibitory measures are not strictly observed we need not be surprised if the salmon fisheries do not increase as much as is hoped for. It is probable, however, that they would have declined still more if they had not here and there been aided by artificial fish-culture.

The Norwegian Government is fully aware of the necessity of a change as regards the stricter observance of the prohibitory measures, and some time ago laid before the Storthing (the Norwegian Parliament) the draft of a law aiming at a uniform regulation of the salmon and salmon-trout fisheries. Among the reasons for this law the decline of the salmon fisheries is mentioned, and their promotion by strict

prohibitory measures pointed out as an urgent necessity. The proposed provisions of the new law go very far, prohibiting, among the rest, the catching of salmon and salmon-trout in the sea from August 26 to April 14, and in the rivers from August 26 to April 30. (See *Deutsche Fischerei-Zeitung*, 1883, p. 262.)

DENMARK.

Although Professor Malmgren does not mention this country in his report, I must briefly refer to it. For the information given below I am obliged to the editor of the Viborg Fishery Journal.

As in Denmark the fisheries are not regulated by law, and prohibitory laws are unknown, artificial fish-culture is only carried on to a very limited extent. Years ago salmon-culture was carried on in Denmark, but only on a very small scale. In Jutland there are at present only five fish-cultural establishments, principally engaged in raising sea and brook trout. The quantity of eggs annually hatched in these establishments varies from 20,000 to 300,000, and the fry obtained in this way is planted in lakes, ponds, and brooks. The oldest fish-cultural establishment in Jutland is the one in Viborg, which was founded in 1865, in order to stock the lakes of that neighborhood with lake trout (*Trutta trutta*), which hitherto were not found there. The acclimatization of this trout in the lakes near Viborg has been successful, and this migratory fish has become a permanent fish. Since the Viborg establishment has annually planted 20,000 of the fry of this fish, several hundred pounds of *Trutta trutta*, mostly weighing from 5 to 10 pounds apiece, are annually caught in these lakes. The result would be still better if circumstances did not prevent the use of large nets and allowed only the use of small nets and lines. These acclimatized sea trout differ from their relations in the sea by having a shorter and broader shape; their flesh is never red, but always white. Although the Viborg establishment is only of limited extent, the results obtained are nevertheless a proof of the of success artificial fish-culture.

It is a very remarkable fact that of late years numerous schools of young salmon have made their appearance near the Danish island of Bornholm. Enormous quantities of these fish have been caught there during the last few years. I would, in this connection, refer to an article by Finn on the fisheries of young salmon near Bornholm (*Deutsche Fischerei-Zeitung*, 1883, p. 145), which, written in favor of prohibitory measures, says that beyond a doubt these young salmon came from the rivers of some other country on the Baltic, as no salmon-culture whatever is carried on in Bornholm. It is probable that these young salmon are the products of Swedish and German salmon-culture. Just as with us, the Bornholm fishermen maintain that these young salmon are not *Salmo salar*, but a smaller kind of salmon spawning in the sea, a vague assertion which is only made in excuse of these reckless fisheries.

UNITED STATES.

Professor Malmgren admits that some good results have been reached in shad-culture, but as regards the results of other fish-cultural experiments he is exceedingly skeptical. The results obtained in shad-culture deserve some fuller mention than Professor Mamlgren makes of them. The shad had become somewhat rare in the American rivers, so much so, in fact, that when Professor Baird in 1873 intended to make a beginning with shad-culture in the Savannah River, Georgia, he could not obtain there the necessary spawners. The first attempt at shad-culture was made in the Connecticut River in 1867, and during the period from 1868 to 1873, 29 shad hatcheries were engaged in the culture of that fish in the United States. Convincing proof of the favorable influence of artificial fish-culture was furnished in the Connecticut River, where young shad had been planted since 1867. In the spring of 1870 unusually large schools of this fish were observed in Long Island Sound, near the mouth of the Connecticut River, and in May of the same year such enormous masses of shad were caught in the river as to throw into the shade even the best fish years of former times, some hauls yielding from 2,000 to 3,000 fish. The number of fish caught in 1871 and 1872 was even greater, exceeding anything since 1811. In 1872 the price of shad on the Connecticut River fell to from 5 to 10 cents apiece.

On the Hudson and the Merrimac the number of shad has likewise increased greatly. On the Hudson the price of shad in 1877 fell to 5 or 6 cents apiece, and these fish were cheaper than 20 years ago, when the price was three times as high. (Circulars of the German Fishery Association, 1874, p. 68; 1875, p. 327; 1877, p. 43.)

Satisfactory proof of the success of salmon-culture in the United States has also been furnished in the Connecticut River. After the salmon, in consequence of the construction of a weir, had since 1798 gradually disappeared from this river, a beginning was made in 1869, with the planting of salmon fry above the weir. In 1878, the salmon again made their appearance in the Connecticut River, and by the middle of June of that year 500 salmon had been caught. (See Von Behr's "*Amerikanische Lesefrüchte*" in Circulars of the German Fishery Association, 1878, p. 77, and 1879, p. 68.) Artificial salmon-culture has likewise proved very successful in California. As Professor Baird reports, the stock of fish in a California river, where annually 2,000,000 fry had been planted, rose from 5,000,000 to 15,000,000 pounds. (*Deutsche Fischerei-Zeitung*, 1838, p. 316.)

Successful attempts have also been made in the United States to cultivate artificially the cod. After the United States fish-cultural establishments at Gloucester and Wood's Holl, Massachusetts, had planted fry of the cod, the fishermen on the coast of New Hampshire, near Portsmouth, in the autumn of 1882, observed great numbers of small cod-

fish, measuring from 4 to 6 inches in length, something which had never been observed before. (*Deutsche Fischerei-Zeitung*, 1882, p. 369.)

Artificial fish-culture in the United States has been materially aided by the Government, and has been very successful. It should, however, be remembered that all these experiments have been made in the American style, that is, on a vast scale, the number of young fry planted far exceeding those planted in Germany.

CANADA.

The same zeal for promoting the fisheries has been displayed in Canada, in whose waters the number of fish had more or less decreased. Since the end of the sixth decade of the present century it has been the aim of the Canadian Government to promote the fisheries by suitable prohibitory measures, by aiding artificial fish-culture, and by constructing fish-ways. As Professor Malmgren states in his pamphlet, it was Samuel Wilmot who earned great credit by introducing artificial fish-culture in Canada. In the autumn of 1866 Wilmot made the first experiments with salmon-culture in Baldwin Creek (now Wilmot's Creek), a small river in Ontario. At that time salmon were not frequent in that part of Canada, for in the autumn of 1867 only about 30 were caught. In the autumn of 1868 numerous young salmon made their appearance in Wilmot's Creek, measuring about 22 inches in length; among all these salmon there were only three old ones. For twenty years no young salmon had been seen in these waters, and there could hardly be any doubt that this was a result of artificial fish-culture. The continued planting of fry since 1868 has tended to increase the number of salmon, so that in 1869 in the fish-house, which the salmon enter of their own accord for the purpose of spawning, more than three-hundred were observed at one and the same time. A great many more, engaged in spawning, were observed in the portion of the river extending from the fish-house to the lake (two English miles). (See Jagor, *Fischerei in Kanada*, in Circulars of the German Fishery Association, 1873, pp. 20 and 21.)

After such favorable results the Canadian Government has not failed to extend material aid to artificial fish-culture, so that in 1881 there were ten hatcheries where, besides salmon, the whitefish (a kind of *maräne*), lake trout, and brook trout were cultivated, the two last-mentioned kinds, however, only on a limited scale. Satisfactory results were reached with whitefish in the Detroit River, where the Canadians in 1878 caught 45,800; in 1879, 77,700; and in 1880, 103,500. The current expenses for Canadian fish-culture in 1880 amounted to 12,000 marks [$2,856], and in that same year 21,500,000 fry were produced, among these 1,800,000 whitefish. In rivers where the salmon had become exceedingly rare, these fish have increased from year to year, thanks to the active efforts in the matter of fish-culture. (See Raveret-Wattel's Report on Foreign Fisheries in Circulars of the German Fishery Asso-

ciation, 1882, p. 68 *et seq.*; and Report of the Michigan Fish Commission in Circulars of the German Fishery Association, 1882, p. 71.)

Professor Malmgren thinks that there are no reliable data on the results of fish-culture in Canada, and that the undeniable fact of an increase in the number of fish must be owing to strict prohibitory measures. Without attempting to inquire why Professor Malmgren feels constrained to doubt the reliability of the Canadian reports, I must state that, for my part, I am inclined to believe that the undoubted results are caused by culture and prohibition combined. Why should the increased number of fish be caused only by natural spawning protected by prohibitory measures? Does Professor Malmgren not consider artificially-produced fry capable of life and development, or does he share the opinion of some people, that only artificially-produced fry, but not that which is produced naturally, becomes the food of larger fish? I am not able to explain the contradiction in Professor Malmgren's views, and shall be greatly obliged to any one who will assist me in solving this problem.

I herewith close this sketch, which gives merely an outline of the results which, so far, we have been able to chronicle in the matter of artificial fish-culture. The reader may judge for himself, whether the verdict which Professor Malmgren has pronounced on artificial fish-culture is justified by the facts. Let us rejoice in the results reached so far, and not be discouraged by pessimistic views like those expressed by Professor Malmgren, but continue to develop this industry in a rational manner. Quiet labor will find its reward in the future.

FREIBURG, BADEN, GERMANY.

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XXXII.—POND CULTURE.*

By Carl Nicklas.

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Die Teichwirthschaft. From the *Lehrbuch der Teichwirthschaft* (Manual of Pond Culture). Translated from the German by Herman Jacobson.

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INTRODUCTION.

There are four different methods of cultivating fish:

1. Pond culture.—*a. Fish-culture, i. e.*, cultivating fish in spawning ponds (in which the fish spawn and in which the eggs are hatched), raising ponds (in which the fish remain till they have reached a considerable size), and stock ponds (in which the fish are fattened for the market), or in inclosed portions of streams. Fish-culture, therefore, means the natural production of fry and raising the fish for the market. *b. The keeping of fish* in raising ponds, stock ponds, or in inclosed portions of streams; in other words, raising young fish which have been obtained from abroad, and keeping them till they are ready for the market.

2. Transplanting fish from one water to another, *i. e.*, transferring a number of sexually mature fish to water in which prior to this no such fish were found.

3. The Chinese method, which consists in gathering from the water the spawn of fish deposited in a natural manner, and transferring it to other places to be hatched.

4. Artificial fish-culture in a narrower sense, *i. e.*, extracting from the fish by human agency their sexual products, uniting the male and female products, and protecting the eggs and young fish from their natural enemies until the umbilical sacs are absorbed.

In the following pages we shall treat only of the first-mentioned method, although we shall at times in the proper connection allow ourselves some digressions relative to the methods.

Pond culture can be carried on only in sheets of water in which one can arrange the water at all times according to his discretion. Such waters are principally ponds, though they are sometimes lakes and inclosed portions of streams.

The larger and smaller lakes, which are termed inland waters, are formed either by the gathering of water in low ground along the course of rivers and brooks, in other words by streams overflowing their banks, in which case these rivers or brooks flow through the lakes formed by them without undergoing any change, or divide into several branches, or occasionally find a subterranean outflow, or such lakes are the natural receptacle for the water of an entire neighborhood, and are formed by springs or by the waters flowing down from the mountains; or they owe their existence to invisible subterranean streams.

Large lakes must come under the head of the "wild fisheries," as their water cannot be let off or diminished; and the principal condition for successfully carrying on these fisheries is "to know how to catch fish." Man can make his influence felt only by increasing the number of fish.

by protecting them during the spawning season, and by introducing finer kinds of fish by placing young fry or eggs in such lakes.

Lakes are never laid entirely dry, but, according to their origin, they either keep a constantly even depth of water or their water rises during a rainy season, and falls during a period of drought. If lakes are not too large, it is in many cases possible to control the water by artificial means, *i. e.*, to decrease it whenever desirable; and if this is the case, such lakes may be used for artificial fish-culture or "tame fisheries" and even for keeping fish.

But before such artificial means are resorted to, a careful estimate should be made in order to ascertain whether there is any reasonable hope that the results will justify the outlay. Special distinction should in this connection be made between the lakes which have a constantly even depth of water, and those which owe their origin to an accident, *i. e.*, which have been formed by the rain or snow water of a neighborhood. Such lakes may contain a considerable amount of water in spring or after a long continued rainy season, but it is uncertain whether the quantity of water will remain the same during summer; and they can either not be utilized at all for fish-culture or only to a very limited extent, so that the expenses of controlling the water by artificial means would be too great. It is possible, however, to transform such waters by degrees to profitable fish-ponds.

As a general rule we understand by "fish-pond" a reservoir which is suitable for fish-culture and for keeping fish, *i. e.*, which combines a suitable location, the proper soil, and water which, when necessary, can be either decreased or let off entirely. To carry on fish-culture and the keeping of fish in such ponds is termed "pond culture," and as a general rule it forms part of agriculture. Pond culture, therefore, comprises the laying out and the construction of ponds, their maintenance, the carrying on of fish-culture or the keeping of fish in such ponds, and the other uses to which such ponds may be put.

Most of our establishments where pond culture is carried on date their origin centuries back, and in the course of time their condition has naturally undergone many changes. The income from agriculture (I include in this term stock raising) made the utilization of the soil for agricultural purposes appear more profitable than pond culture. Many ponds were laid dry and used as fields with increasing profit, for the price of grain had risen, while the price of fish had declined steadily. In many parts of our country this is now reversed, as agriculture does not yield so large a profit as formerly, while the price of fish has risen enormously, in illustration of which we will only state that within a period of twenty-five years the price of carp has risen from 30 marks [$7.50] to from 60 to 70 marks [$15 to $17.50] per hundred-weight.

Nevertheless I would not unconditionally advocate at this day the establishment of new ponds with the view of carrying on fish-culture

(carp-culture) on a large scale, for who could guarantee in our times, which, as regards economy, must be termed a period of transition, that the present condition will continue even for a few decades?

I do not therefore unqualifiedly advocate pond culture, and I do not maintain that pond culture is calculated to make a certain piece of ground yield the largest possible net income, or at any rate a larger income than agriculture, which, under favorable conditions of soil, and by being carried on in accordance with the demands of the time, will generally yield a larger and more certain profit than fish-culture. Even if in some localities the income is not so large, a few acres of cultivated ground will support the man who cultivates them in the proper way, which cannot always be said of the same area used for pond culture. (We do not here refer to small fish-cultural establishments, or establishments of pond culture carried on like any other branch of industry; but even these, if conducted on the same principles as large establishments of this kind, would not yield a larger profit per acre than ordinary establishments of pond culture.) The conditions referred to are mostly only of a local character, and are not permanent, either as regards agriculture or pond culture, and, as heretofore, they will, in course of time, undergo many changes.

If we take into consideration the fact that strenuous efforts are made in our time to increase the number of fish by artificial hatching and by transplanting young fish of species far superior to the carp to waters which hitherto did not contain any fish, we cannot but think that by the consequent extension of the "wild fisheries," especially as regards the finer kinds of food-fish, it will not take more than ten or twenty years to reduce the price of carp to that of twenty-five years ago, while, on the other hand, agriculture and stock raising are constantly becoming more profitable.

Although it will therefore be the first duty of a person owning large sheets of water to inquire whether he cannot drain some of them and transform them to fields and meadows, it cannot be denied that there are many lakes which cannot possibly be drained, and which naturally suggest the question in what manner their waters may be put to the most profitable use, and what means should be employed to adapt them to fish-culture.

It is often impossible to drain entirely a large area of marshy soil; but by digging ditches and constructing dikes the water may be made to recede to the lower ground, where, if not allowed to flow any farther, it will form a natural basin of water, varying in size according to local conditions. Much has been gained hereby, as part of the ground has become suitable for fields and meadows, and as the newly-formed lake may at a comparatively small expense be used for purposes of fish-culture, while formerly the entire area, being marshy, yielded only a scanty harvest of sour and unwholesome hay.

If such a lake (it becomes a pond only by constructing works for filling or draining it at any time) has had its origin in the manner described above, or if it is the natural meeting-place of waters from springs on higher ground or of the rain or snow water of an entire neighborhood, or if the water has been gathered in one place for the purpose of furnishing power for some mill or other factory, it will in all cases be possible to utilize the water for pond culture, unless it is polluted by refuse from the factories.

The main question, under all circumstances, will be, in what manner this water can be made most profitable for pond culture. On the other hand it cannot be denied that pond culture, as it is, has not yet reached that degree of development which would make it impossible to derive still greater profit from it; all the more it should be the object of our pond culturists to obtain the greatest possible benefit from their ponds, so that this culture, as far as its results are concerned, may keep step with agriculture, and furnish a means of support in times when the income from the latter is but small. Pond culture teaches how this object may be attained and how fish-culture, and more especially carp-culture, may be made to yield the greatest possible profit. It may be divided into two parts: (1) The laying out, construction, and keeping of ponds; and (2) Fish-culture in these ponds.

I.—The Laying out and Keeping of Fish-ponds.

In this chapter we shall speak only of such ponds as have been laid out and are kept for the purposes of raising and keeping fish, where fish culture, therefore, forms the object and the ponds are the means for attaining this object; while in cases where the laying out of ponds has for its object to furnish water-power for mills, &c., fish-culture appears as the means to derive still greater benefit from existing ponds.

Before laying out one or several ponds, the following points should be considered: (1) The location of the ground; (2) the configuration of the ground; (3) the quantity of water on hand; (4) the quality of the water; (5) the quality of the soil; (6) safety from inundations; (7) legal right to use the water; and (8) the cost.

All these points must be supposed to be settled in existing ponds, but even in these, there is, in many cases, a chance to make improvements; but in order to make these improvements the existing conditions should be carefully examined, and the consideration of the above points may prove useful to persons who possess old, established ponds.

1. The location of the ground suitable for laying out a pond should be open on all sides, so that the pond may have the benefit of the sun all day long; for the heat of the sun does not only further the growth of fish, but also the development of fish-food, worms, and insects. It does not hurt, however, but on the contrary is an advantage, if a portion of the pond is, at a suitable distance, surrounded by woods and

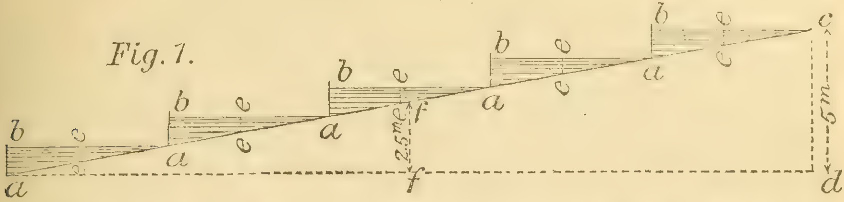
heights, especially on the north side, so as to break the force of the wind from that quarter and prevent it from making the water of the pond too cold. It is not necessary that the pond should be located in a level plain; on the contrary, a sloping ground will prove an advantage, because thereby a natural and very inexpensive means is afforded for the water to flow off; on the other hand ponds located on low ground or in plains have the advantage of receiving the rain and snow water from the higher ground which contains a great deal of fish-food, and which forms a layer of rich mud at the bottom of the pond.

2. THE CONFIGURATION OF THE GROUND.—The plain selected for the laying out of a pond should be even in all directions, and should incline only on one side, so that it is possible to drain the pond entirely in a short time. If, however, the plain slopes on several sides, as is frequently the case in large ponds or lakes, and if this cannot be remedied the water should have a chance to flow off on all the slopes. Under these circumstances, however, the laying out of a pond becomes more expensive, because it necessitates the construction of dikes and contrivances for the outflow of the water. The most suitable ground for the laying out of a pond is that which slopes a little towards the center. Within the limits of the pond there should be no depressions, as during the time when the fish are caught, some are apt to hide in these places, thus making fishing difficult. Such depressions or holes should, if possible, be filled, and if they are too large or too numerous to do this, the ground is not suitable for the laying out of a pond, as the fisheries in such a pond will involve too great an expense. If, however, the ground possesses a depression in such a place and of such a size as to make it possible to construct the outlet for the water near it, it forms a natural reservoir for the fish, which saves a great deal of labor. If there are in the pond large shallow places it is best to construct dikes round such places, so as to prevent the fish from entering them, and plant these dikes with willows.

The first object in selecting ground for a pond is to obtain the most suitable depth of water for the fish. As a general rule the average depth of water best suited for most kinds of fish is 45 to 50 centimeters. A depth of 80 centimeters is not favorable. It is necessary, however, that a ditch measuring 1.5 meters in depth should cross the entire area of the pond from the place where the water enters to its outlet, where it should widen out, without changing its depth, thus forming a reservoir for the fish and preventing their freezing in winter. In case, however, the pond is never to be used for wintering fish, the dimensions of this ditch may be smaller, unless the quantity of water flowing into the pond requires them to be larger. Several small ditches—their number to be regulated by the size of the pond—should run from the shores of the pond to the main ditch, and the ground should therefore slope gently in the direction of these ditches. On gently sloping ground, which, however, would make the depth of the pond too great if the entire area was

to be used for one pond, a suitable depth of water may be obtained by forming several ponds by constructing dikes rising on terraces one above the other.

Fig. 1.



Taking, for example, an area 700 meters long, *a c*, and 200 meters broad, equal to 14 hectares, whose grade per 700 meters is 5 meters, *c d*, and therefore 2.5 meters in the middle, we would have to divide it into five parts by constructing dikes at the points marked *a*, whereby we would obtain a maximum depth, *a b*, of 1 meter and a medium depth, *e e*, of 50 centimeters. (In order to show these depths in the limited space of the illustration different scales had to be adopted for the lines *a c* and *c d*, which, however, will not prevent it from being sufficiently intelligible.) The ground should not slope too abruptly, as, in spite of terraces, the water could not be prevented from rising too high, and as, moreover, very high and therefore expensive dikes would be required. In such cases it may be recommended to utilize the upper parts as meadows. Wherever the above-mentioned conditions, described as either necessary or favorable, do not exist at all, or only in part, the laying out of a pond (if not entirely impossible) will be very expensive, and will also render fish-culture a costly experiment.

3. The quantity of water.—It should, in all cases, be possible to furnish the pond with a sufficient quantity of water, which, if possible, should be fresh. Ponds generally are found in plains or on low ground, and receive their water either from springs, brooks, rivers, or from other ponds and swamps, or their supply is furnished by the rain and snow water flowing from hills and mountains. Ponds which are supplied with water in the last-mentioned way are termed "sky ponds," as they are entirely dependent on the moisture of the atmosphere. Ponds should at all seasons of the year have the necessary and unvarying, as far as possible, depth of water, so as not to endanger the life of the fish during hot and dry summers. Before laying out a pond special attention should be paid to the way in which water is generally supplied to the ground which has been selected; and it will be necessary to ascertain what was the average quantity of water supplied during a number of years, and more especially what were the conditions of such supply during the last months of summer. The most reliable depth of water will be found in those ponds which are filled by canals from neighboring brooks and rivers, or through which rivers flow, or which draw an ample supply of water from never-ceasing springs.

Especially in the case of lakes formed merely by rain or snow water, which are to be transformed to fish-ponds, it will be absolutely necessary to ascertain whether during a period of many years there was ever any lack of water, what is their usual depth of water, and whether this depth remains the same during winters when there is but little snow and during dry summers. Even if this should be the case, it will always be advisable, in order to be sure of success, to fill such "sky ponds" immediately after the autumn fisheries. In order to secure a permanent and even depth of water in such ponds, they should have as many feeders as possible, so that at every rainfall, and during the thaws of spring, all the water from the surrounding country may flow into them.

Before laying out such ponds one ought to ascertain whether, in case of necessity, leave will be granted to carry these feeders or ditches through territory belonging to other persons. Water obtained through such feeders generally carries a great deal of fish-food into such ponds. If there is no difficulty about filling them with water—and there generally is no difficulty as regards "sky ponds" measuring 30 to 40 hectares (and even more), if one does not shun the expense of supplying them with water from distant regions—they must, especially if the soil is of the right kind, be considered as among the very best ponds, as, owing to the excellent fish-food carried into them by the feeders, the growth of the fish will be rapid and healthy.

4. THE QUALITY OF THE WATER.—It is certain that some kinds of water are better adapted to fish-culture than are other kinds, but, as a general rule, persons, in laying out a pond, will not have much choice, but will have to take the water as it is, as its quality depends on the nature of the country and other circumstances which cannot be changed. We have already mentioned from what points of view and in what manner water should be examined, before using it for a fish-pond, and we may here simply refer to what has been said before. Water containing any substances which are injurious to fish, and which cannot be purified, should of course not be used for fish-ponds. If no other water can be obtained, the idea of starting a fish-pond in the locality should be forthwith abandoned. As a general rule those ponds seem to be the best whose water is supplied by brooks and other small but never-ceasing streams. The water, however, should not come from forests in the immediate neighborhood of the ponds, as it is apt to be too cold, and contains but little fish-food; while water, which, prior to its entering the pond, flows for a considerable distance through cultivated ground, will be much warmer and be saturated with nourishing matter, thus being in every respect suitable for a fish-pond.

Director Horak says the following relative to the advantages and disadvantages of the different kinds of water which are used for supplying fish-ponds: "Such water is either—

"*a. Pure spring water*, which contains but little fish-food, is gener-

ally cold, and not well adapted to fish-culture. Fish of prey, especially trout, which live on their fellow-beings, will flourish in such water. If a pond fed by spring water exclusively has a sandy bottom, it must be classed among the so-called poor ponds; if such water contains a considerable quantity of animal refuse, it is hurtful to the fish and should be allowed to flow off. A pond containing such water can only be used for fish-culture if other and healthier water is introduced.

"*b. Snow and rain water* contains nutritive matter in a diluted form, fills the ponds evenly, and is beneficial to the fish during the rainy seasons and thunder-storms which occur during summer. Rain-water invariably contains a good deal of fresh nourishing matter.

"*c. Brook and river water* is more or less soft or hard, according to the influence which the heat of the sun has upon it and the quantity of foreign matter which it carries along with it. Ponds are generally supplied by this water which, on the whole, is favorable to fish-culture.

"*d. Peat, marsh, or forest water* is usually pure, of a dark color, and marshy flavor. It contains but little fish-food, and becomes suitable for fish only after having been in the ponds for some time, exposed to the influence of the atmosphere and mixed with snow, rain, and other water. If such water flows into the ponds from peat-bogs and marshes, the ponds will be poor, and can only be improved by being drained frequently and by introducing rain-water from the nearest fields.

"*e. Pond water* is suitable, as a general rule. It is warmer than river or spring water, and is specially adapted to the supply of winter ponds and tanks. The water of good ponds, or of ponds which at certain periods are used for agricultural purposes, contains dissolved substances and is wholesome for fish. Muddy water coming from cultivated fields carries much humus and nutritive matter. If the water of a pond when agitated by wind remains colorless and clear, this is an indication that the soil is poor, while a brownish-yellow water indicates a rich bottom. Water from peat-bogs or from iron mines, or water which is saturated with manure or particles of lime, is hurtful to the fish, and unless a sufficient quantity of pure water is introduced the fish will grow sick or die out. Reddish water, having an oily surface, contains too much iron, tannin, and gallic acid, and is, therefore, injurious to fish. Water which, during the rainy seasons, flows into the ponds from cities and villages contains much new and rich food-matter, and should, therefore, be employed whenever practicable, of course preventing any large quantity of manure water from mingling with it. Water from chemical factories is generally hurtful to fish."*

5. THE QUALITY OF THE SOIL.—The bottom of the pond should retain the water and be well supplied with fish-food. The main source of fish-food will always be the bottom of the pond, for it is not certain that the water flowing into the pond will contain a sufficient quantity of food. Sandy loam soil or loamy sand soil will contain most food.

* Horak, *Teichwirthschaft*, 1869.

The humus contained in these kinds of soil is dissolved and supplies food to the fish; it also favors the production and growth of many kinds of plants, worms, and insects, all of which are excellent fish-food. The above-mentioned kinds of soil combine two great advantages, viz., to supply a sufficient quantity of suitable food, and to retain the water. Clay soil, when containing sand, is likewise rich in food, and retains the water, even during long periods of dry summer weather, and is therefore the best for "sky ponds." If the soil is loose, or even sandy or gravelly, the water soon percolates through it, and neither insects nor plants can thrive, as the productive power of the soil is but small. It therefore affords but little food to the fish. Ponds having such bottom can only be maintained as fish-ponds by a constant and superabundant supply of water from cultivated ground.

But even as regards existing ponds the pond culturist should possess an accurate knowledge of the quality of the soil of every pond; he should therefore examine it carefully, for only thereby will he gain a thorough knowledge of the exact condition of his ponds, enabling him to make improvements wherever needed. An accurate knowledge of the nature of the bottom of the ponds is as essential to the success of the pond culturist as a knowledge of the soil and its different layers is to the agriculturist. The examination of the bottom of a pond, as regards the quantity of food-matter contained in it, will be easiest, and lead to the most satisfactory results, just after the pond has been drained, but not after it has lain entirely dry for some time, for it is of interest to the pond culturist to know what plants and animals are contained in the pond when it is full of water. If the pond has been dry for any considerable length of time most of the plants and insects which owe their origin and life solely to the water have either disappeared entirely or have decayed. After this first examination the soil of the pond should again be examined after it has become entirely dry, so as to obtain an exact knowledge of its component parts. Such an examination should, especially in large ponds, be made in a number of places, for the soil of a large extent of ground will vary considerably.

If, after the pond has been drained, a great deal of mud is found at the bottom, this is a sure indication of rich soil. In that case the bottom is generally composed of clay or loam with a slight admixture of sand, and the mud produced by the decay of the many products of this rich soil, and partly introduced by rain or snow water, will directly serve as food for fish, and also indirectly answer the same purpose by becoming the abiding-place of many insects and plants which fish eat. The water of such ponds is generally muddy, and has a brownish-yellow color.

6. PROTECTION AGAINST INUNDATIONS.—If a neighborhood is exposed to frequent inundations, special attention should be given to this matter before the pond is laid out; for if it is impossible to secure ponds against such calamities, the entire fish harvest will frequently be lost.

If ponds receive their water from springs, brooks, or rivers which rise considerably at certain seasons of the year, weirs with sluices should be constructed at the places where the water enters the pond, so that the supply of water can easily be regulated. If, however, an entire stream passes through a pond, the weirs must be placed in the stream itself, and the superfluous water must be allowed to flow out through side ditches. The superfluous water and the water of the stream may again unite below the pond.

7. LEGAL RIGHT TO USE WATER.—As regards the legal right to use the water coming from some distance, it will be well, before laying out a pond, to examine whether one is entitled to draw the water from the brooks, rivers, and springs which it is intended to use for supplying his pond. With "sky ponds" this is of course not necessary, but the consent of the neighbors may be required for constructing ditches through their property, so as to regulate the supply and outflow of rain and snow water. As regards existing ponds all this has probably been satisfactorily arranged long since; but when new ponds are to be laid out this may involve such difficulties and expenses as to prevent the whole scheme.

8. THE COST.—After all the above conditions for laying out a pond have been examined in the manner described, and have been found favorable, the question of the cost will have to be considered, and careful calculations should be made for the purpose of ascertaining whether the expenses connected with the laying out and the maintenance of the ponds will be so large as to be utterly disproportionate to the profits which may reasonably be expected from pond culture. The decisive point will be whether the laying out of a pond will insure the return of the capital invested within a reasonable period.

II.—THE CONSTRUCTION OF PONDS.

INTRODUCTION.

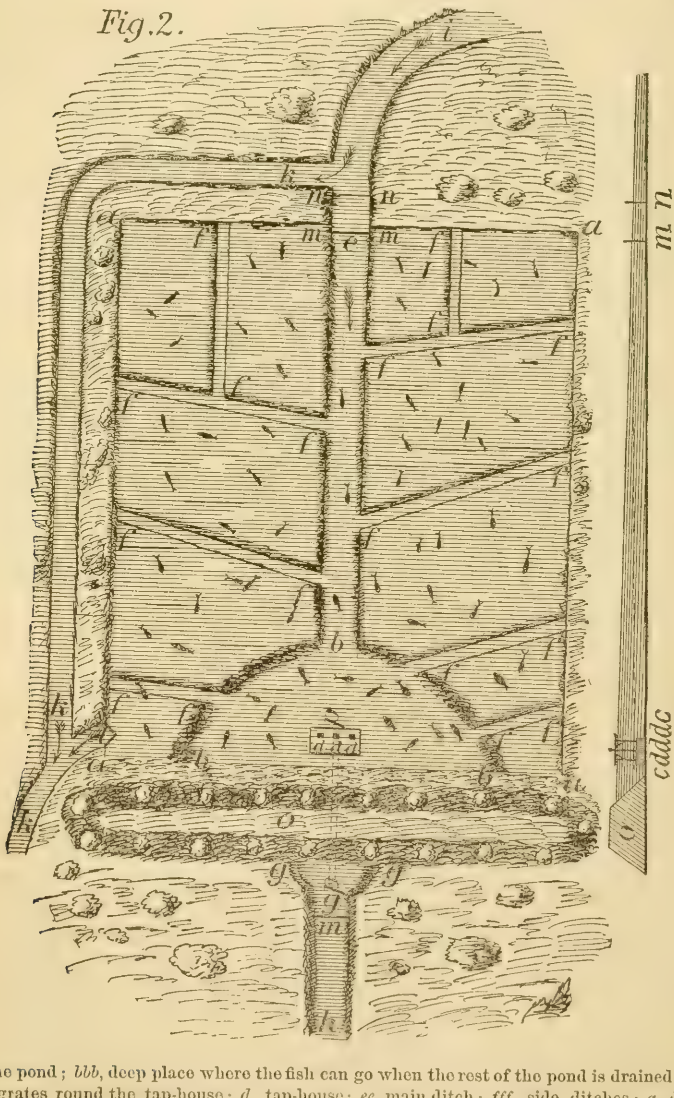
In the preceding chapter we have shown what conditions should be observed in the laying out of a pond; and in the present chapter we intend to show the manner in which ponds should be constructed in cases where all the above conditions are more or less favorable.

In laying out a pond the conditions of the ground should, as we have already mentioned, be carefully examined and the plan be made accordingly, one of the most important points being to secure a suitable depth of water. We have likewise indicated in the preceding chapter in what manner this should be done. The depth of the water is regulated by making the level of the water in the ditch through which it flows into the pond higher than the foot of the grate where the water flows out. The higher the foot of the grate, so much larger an area can be evenly flooded, and the lower the foot of the grate, so much smaller an area. The area of the pond should be determined by the quantity of water

that can be used, and by the manner in which it is supplied, so as to prevent a lack of water in dry summers. No fixed rules can be laid down for this; and it will always be advisable in the beginning to flood only a comparatively small area by placing the bottom of the grates as low as possible, and it will soon appear whether it will be necessary to flood a larger area in order to obtain a suitable depth of water in the pond.

For the better understanding of the following, we will give here a ground plan and elevation of a fish-pond, showing its different parts.

Fig. 2.



aaaa, the pond; *bbb*, deep place where the fish can go when the rest of the pond is drained—the fish-pit; *cccc*, grates round the tap-house; *d*, tap-house; *ec*, main ditch; *fff*, side ditches; *g*, deep place where those fish are retained which escape through outlet pipes—the outer fish-pit; *h*, outlet; *i*, ditch through which the water flows into the pond; *kk*, ditch for superfluous water; *l*, grates; *m*, weir; *o*, dike; *p*, outlet pipe passing underneath the dike.

As a general rule small ponds are preferable to large ones, and the increased cost, occasioned by a larger number of dikes, will be amply repaid; for the water in small ponds can be rapidly heated by the sun, and in proportion to their size they afford more food for the fish than large ponds, and the fishing will be less expensive. This should be specially borne in mind in constructing a large pond, involving the necessity of including within its limits high ground having gravelly soil, which is of no value for fish-culture, and which would only produce a depth of water in the lower portions which would prove unfavorable to vegetation. The above, of course, applies only to the construction of new ponds; while in existing ponds inquiry will have to be made whether, and in how far, they answer the above conditions, and what improvements may be introduced either at the present or at some future time.

The work of constructing a pond may be subdivided as follows: (1) Building the dikes; (2) Constructing the principal ditches; (3) Constructing the side ditches; (4) Preparing the deep place where the fish go when the pond is drained—the fish-pit; (5) Preparing the deep place on the other side of the dike—the outer fish-pit; (6) Constructing the ditches for the superfluous water; (7) Making the proper arrangements for letting the water in and out; and (8) Placing the grates in position.

1. THE DIKE.

The building of the dike is the first work which should be done when a pond is to be constructed, for it serves to prevent the water in certain places from flowing any farther. It gathers the water, and thus forces it to spread in both directions above the dike. In large ponds, which frequently slope also toward the sides, it will sometimes be necessary to construct dikes along the side; but the pressure of the water against them will not be nearly so strong as against the main dike, and they therefore need not be built so solidly.

As a general rule, dikes should be constructed only on that side of the pond where the water is to be stopped in its flow. They have therefore to resist the pressure of the entire mass of water which rushes against them with full force. In order, therefore, for the dike to answer its purpose, *i. e.*, to resist the rushing waters, it must be built solidly. The larger the pond, the stronger the fall of the water, and the deeper the water, the more powerful will be the pressure against the dike, and the strength of the dike should be proportionate to the force of the water rushing against it.

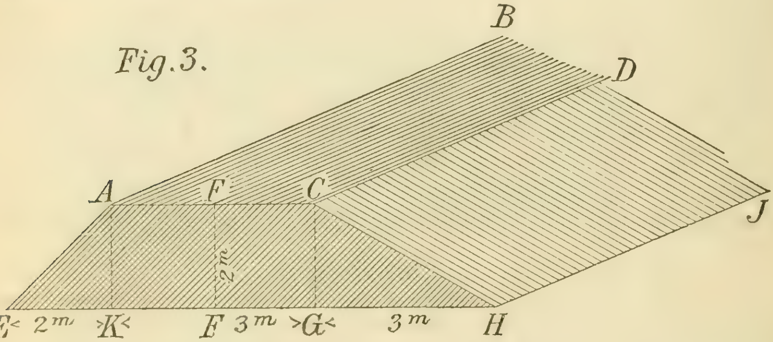
In order to possess the necessary strength a dike should be solid, should have the requisite height and breadth, and its sides should slope in such a manner that the water cannot easily break through or overflow it. The solidity of a dike does not only depend on the manner in which it is constructed, but also on the material employed. Dikes are con-

structed of earth, wood, or stones, but in all cases the most important point will be the foundation.

The form of dikes differs according to the locality and the configuration of the ground. Dikes may therefore be either straight, or have one or several angles, or be constructed in the form of an arch, &c.

In order to answer their purpose dikes should be so high that they rise from 60 to 90 centimeters above the level of the water. In order to ascertain what height of dike will be required, the exact level of the ground which is to be filled with water should be found. If, *e. g.*, the fall for a certain space *a a* (see p. 14) has been found to be 120 centimeters, you add to this the proposed height of the dike above the level of the water, say 80 centimeters, and the entire height of the dike should be 200 centimeters or 2 meters.

Fig. 3.



The breadth of the dike at the top, AC, should be at least 120 centimeters, and as a general rule be equal to the depth of the water pressing against it. If, however, the dike is to be used as a carriage-road, its breadth at the top should be at least from 3 to 3.5 meters.

The side of the dike which slopes towards the water, also called the front scarp, CHJD, which is principally exposed to the pressure of the water, receives at least the double height, FF, as the base of the slope proper GH, and in order to make it still more solid it is covered with stones, fascines, wicker-work, &c.

The back scarp, AE, at its base equals only the height of the dike, FF, and remains uncovered.

That part of the dike which is near the outflow of the water should be particularly solid, and the bases of both its slopes, both front and back, should be of equal extent.

The place where the water is to flow out should be determined before work on the dike is commenced, the pipes should be laid, and the dike built over them.

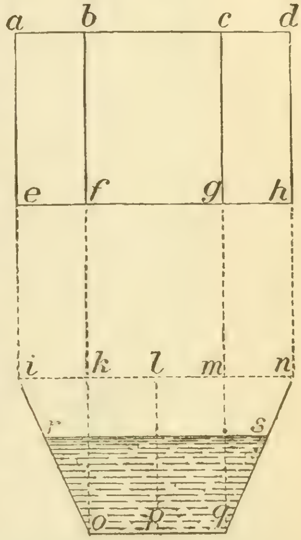
If the sides of the dike are covered with anything—*e. g.*, stones, &c.—the base-line of the scarp, GH, may be shorter.

The top of the dike, ABCD, is called the crest, the lines AB and CD—*i. e.*, the lines where the scarp commences—the edge of the crest,

and the line HJ the edge of the sole. The space between the front and back edge, EH, is called the sole of the dike, and the entire space is called the breadth of the sole.

As regards the ditches the same rules apply to the proportion of their dimensions and to their scarps as with the dikes, and similar terms are used. The inclined side of the ditch is called the scarp *i o* and *n g*. The lines drawn from one bank *i*, to a point *k*, and from *n* to *m*, where (at *k* and *m*) it meets a vertical line, is called the base line of the scarp. The bottom of the ditch, *o g*, is called the sole, the boundary line between the sole and the sides *b o* and *c q* are called the edges of the sole, and the boundary lines between the sides and the banks *a i* and *d n* are called the edges of the bank. The distance, *i n*, from the edge of one bank to the other is called the breadth of the ditch, and the distance from one edge of the sole to the other, *o g*, the breadth of the sole. The distance from one side to the other over the surface of the water, *r s*, is called the breadth of the water-level.

Fig. 4.



A.—*Building the dike and constructing the ditches.*

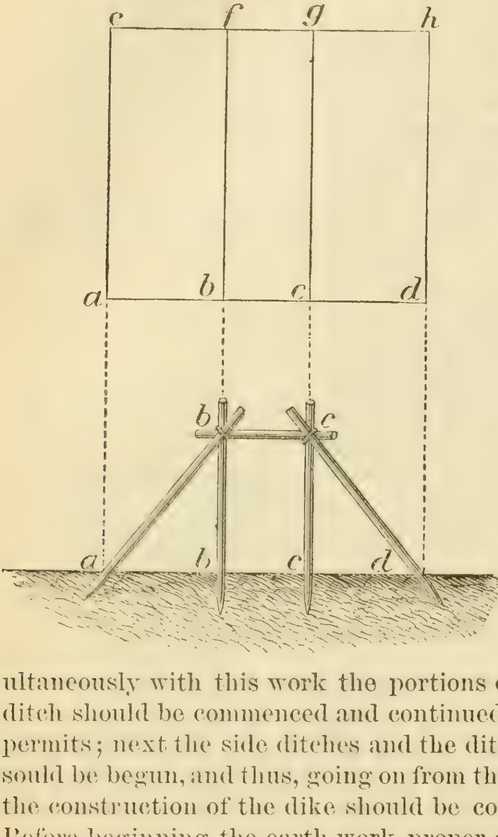
BUILDING EARTH-DIKES.

Before beginning the building of the dike it should be accurately laid out, *i. e.*, along the entire length of the proposed dike, the edge-lines of the crest, *b f* and *c g*, and the edge-lines of the sole, *a e* and *d h*, are marked by pegs and ropes.

As soon as this has been done the elevation is marked by poles and boards, (*a*) (*b*), (*b*) (*b*), (*c*) (*c*), and (*c*) (*d*), first of all at both ends of the dike, and, if it is not to run in a straight line, at every angle. Between the end points intermediate poles are placed along the proposed lines of the dike at intervals of 2 meters. In placing these intermediate poles in position one should begin from the highest points downward; and this rule should invariably be observed, as it will be impossible to find a perfect plain for the building of a dike. The scarps of the angles and the intermediate poles are determined by placing the eye close to the poles at one end and taking aim towards the poles at the other end. In order to insure successful work the poles or boards marking one and the same scarp should all incline at exactly the same angle.

Before beginning the earth-work of the dike one should commence digging some of the pond-ditches and fish-pits, and in order to further the work both should be carried on at the same time, so that earth dug out from the ditches may be at once used for the dike. It will be impossible, however, to commence work simultaneously on all the ditches, as they run in different directions, and the laborers in taking the earth to the dike would interfere with each other; nor can the earth-work of the entire dike be constructed simultaneously with the ditches, unless the main ditch is large enough to supply the earth for the entire length of the dike; but only so much of the dike should be constructed as will be supplied with sufficient earth from the ditches dug at the same time.

Fig. 5.



The main ditch should be the first to be dug, and simultaneously with this work the portions of the dike nearest the main ditch should be commenced and continued as far as the supply of earth permits; next the side ditches and the ditches for the superfluous water sould be begun, and thus, going on from the larger to the smaller ditches, the construction of the dike should be continued until it is completed. Before beginning the earth-work proper of the dike, its bed should be constructed by digging a hole along its entire length and breadth measuring 20 to 40 centimeters in depth, so that the foundation of the dike can be placed in the ground.

The width of the ditches is marked along their entire length by pegs and ropes, while their slopes are generally determined only after the bulk of the earth has been removed from them. If the slopes are to be marked prior to this, the inclination should be indicated by boards.

In order to make an estimate of the cost of the earth-work of a pond, and in order to draw up a plan for the work on the basis of the cost, it will be necessary to know what number of laborers, and what period of time, is required to complete the ditches and the dike. The following data may aid in making these estimates: The number of laborers will, of course, vary according to whether the ground is hard or soft. In this respect the earth may be classed under three heads: Easy to

work (loose sand), tolerably easy (garden soil), and difficult (clayey or stony soil). In order to work conveniently with a shovel a man needs at least a space of 120 centimeters along the proposed site of the ditch, and thus it will be easy to determine the number of shovelers needed for a certain length of ditch. The above-mentioned space, of course, only applies to large ditches, such as those intended to let the water in and out, and in very large ponds also to the side ditches; but for small side ditches this space will have to be considerably enlarged, thus diminishing the number of shovelers, as the men would be in each other's way if placed so close together, owing to the more rapid progress of the work. A laborer can easily throw the earth with his shovel 3.6 meters in a horizontal and 2.3 meters in a vertical direction, which proves that for horizontal distance exceeding 3.6 meters and a vertical one exceeding 2.3 meters two rows of shovelers will be required. This will, however, hardly be necessary except in the construction of very large ponds, which need a very broad and deep main ditch for carrying a stream through them. In dividing the entire length of the proposed ditch in spaces of 120 centimeters, besides the shovelers other laborers will be needed to break the soil, to remove it to some distance, and to level and spread it on the place where the dike is to be constructed. All these men constitute a laboring squad. The distance of these squads from each other depends on the number of laborers at one's disposal, on the time in which it is intended to complete the dike, and on the size of the ditches. The greater these distances the fewer laborers will be needed, and the fewer laborers, all the slower will the work progress.

The above has been said, presuming that one has a sufficient number of laborers, that the pond and dike are to be constructed in the shortest possible time and with the greatest possible saving of labor and money, and that the earth from the main ditch is sufficient for the entire dike, because, although these conditions will in many cases be wanting, the greater portion of the dike should be constructed from the earth of the main ditch, unless this earth is from some cause not adapted to the purpose. If one knows the rules according to which the work should be carried on under these conditions, it will be easy to adapt these rules also to different conditions, and we shall, in the proper place, give some hints regarding this.

To return to the laboring squad, we know from experience that a loose sandy soil, not covered with turf, does not need to be broken, but as the soil down to the bottom or sole of the proposed ditch will often vary in its character, it will be advisable to count on employing some laborers for breaking the soil. For a tolerably easy soil (see above), as well as for sandy soil, one should count one man with a pickax to every two squads, and for difficult soil one such man to every squad, and in both cases one man per squad for leveling and pounding the soil.

Supposing that every shoveler could throw the earth to the place of

its destination (which, however, will be very seldom the case, probably only in very small ponds, and in these along the fish-pit, as the main ditch does not run parallel with the dike, but strikes it mostly at a right angle, and as none of the other ditches run parallel with the dike), a squad working in sandy soil would comprise two and one-half men, and in difficult soil three men; but as soon as the earth is to be thrown farther than 3.6 meters each squad should be increased by one man for every additional 3.6 meters. In large ditches the earth has to be thrown not only horizontally, but also vertically; each squad should, therefore, be further increased by one shoveler; this would make per squad in tolerably easy soil three and one-half men, in difficult soil four men, presuming that the earth is to be thrown 3.6 meters in a horizontal direction. But as the distance to which the earth has to be thrown varies in the different squads, the number of laborers composing a squad will vary according to the greater or less need of additional shovelers.

In order to determine the number of laborers which will be required, the number of squads should be ascertained first, without regard to the shovelers needed for carrying the earth farther than 3.6 meters. The number of squads will be determined by the length of the dike, as these laborers will have to construct not only the ditch, but also the dike. The number of laborers being A, the length of the dike L, the distance assigned to each squad l, and the number of laborers per squad a, the formula is as follows:

$$A = \frac{L\,a}{l}$$

To this number should be added the shovelers who are to carry the earth to the dike.

It will be necessary to know the total of all the distances to which the earth is to be removed by all the squads. The total of these distances, S, supposing the distance of the squad nearest the dike to be A, the distance of the farthest u, and the number of squads n, will be as follows:

$$S = \frac{n(A + u)}{2}$$

We must here observe that there is included in the squad one shoveler who has to throw the earth from the ditch a distance of 3.6 meters. This shoveler we do not count in the following calculations, because we do not count another shoveler for carrying the earth from the edge of the sole of the dike on the water side to that on the land side, and in the same cases on the dike itself.

The above formula is to be solved as follows: With a view of making it plainer we will describe the manner in which the laborers should be placed. This may be done in three different ways: (1) In such a manner that each squad carries the earth to the dike in a straight line, therefore by the shortest route. This is possible only if the work on the fish-pit and on the adjoining part of the dike is not commenced until the

rest of the dike is finished. This is not advisable, however, in spite of its requiring one-tenth less shovelers for carrying the earth farther, because it is much more laborious, and the seeming saving of labor is lost either entirely or in part, and because the portion of the dike thus interpolated, as it were, will never join as firmly with the neighboring portions as when it is constructed simultaneously with them, although it should be particularly solid. For the sake of completeness, however, we will also make the calculation for this case. (2) In such a manner that the earth is carried away on a line running at a right angle with the line of digging. This cannot be avoided if the portion of the dike bordering the fish-pit is be constructed simultaneously with the rest of the dike, as on the shortest straight line the laborers would hinder each other in throwing the earth, as will appear from the drawing given below. (3) The interference of the laborers with each other, mentioned under 2, may be avoided by letting the men who have to remove the earth describe a curve instead of a right angle on their way from the ditch to the dike, which, moreover, has the advantage of causing a saving in shovelers, wheelbarrows, and carts.

It will be impossible, however, to lay down a general rule as to which of these first two methods should be followed, because the configuration of the ground will determine this in each case. Wherever practicable the curve is to be preferred to the straight lines running at right angles.

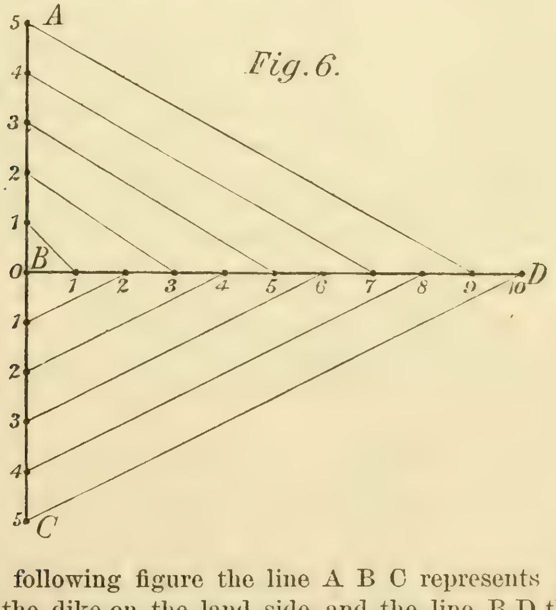


Fig. 6.

1. In the following figure the line A B C represents the edge of the sole of the dike on the land side, and the line B D the proposed main ditch, and it is assumed that the cubic contents of one division of the ditch corresponds to the cubic contents of earth of an equal division of the dike. Supposing this to be the case we can assign to each squad

the same space of dike and ditch. In order to make it clearer we have taken for our illustration a very small pond and a comparatively large scale, 1 to 120, which, however, will make no difference as regards the correct solution of the problem.

We now place along the line of the proposed ditch, at intervals of 1.2 meters, the squads of laborers at points 1 to 10 (we count four men to each squad, viz., one man with a pickax to break the ground, one shoveler who removes the earth from the ditch, one shoveler who throws the earth to the next shoveler, and one man for leveling the earth on the site of the dike). Squad 1 along the line of the ditch removes the earth to 1 on the line of the dike B A, 3 to 2, 5 to 3, 7 to 4, 9 to 5, 2 to 1 on the line of the dike B A, 4 to 2, 6 to 3, 8 to 4, and 10 to 5 of the same line (B A).

It would be an error if, instead of directing the ditch in a straight line towards the center of the dike and letting the laboring squads alternate on the right and left of the ditch, one was to work a part of the dike, AC, placed perpendicularly, or also at an angle at point B of the ditch, with its points A or C, as in that case the work would go from points 1, 2, 3, to 10 along the ditch towards the corresponding points 1, 2, 3, to 10 along the dike. The earth would then have to be thrown one-third farther than is the case in the plan illustrated by our figure. The case would be similar if one was to work from points 1 to 5 along the line of the ditch towards the corresponding points 1 to 5 along the line BC of the dike, and from the points 6 to 10 along the ditch towards the corresponding points 1 to 5 along the line BA of the dike. Moreover, the laboring squads would interfere with each other. This also applies to illustration of method 2, given below.

As will be seen from the figure, one-half of the dike and the ditch form a rectangular triangle, and the lines on which the earth is to be moved towards the dike divide the large triangles BĊD and BAD into a number of smaller ones, whose hypotenuses are formed by the lines on which the earth is removed. If the two sides of the right angle are a and b the hypotenuse will be $\sqrt{a^2+b^2}$. As will readily be seen from the figure, the distances along which the earth is to be removed from the ditch, supposing that a is the space assigned to a squad along the dike and b that assigned to a squad along the ditch, will be as follows:

No. 1 = $\sqrt{1a^2+1b^2}$	No. 2 = $\sqrt{1a^2+2b^2}$
No. 3 = $\sqrt{2a^2+3b^2}$	No. 4 = $\sqrt{2a^2+4b^2}$
No. 5 = $\sqrt{3a^2+5b^2}$	No. 6 = $\sqrt{3a^2+6b^2}$
No. 7 = $\sqrt{4a^2+7b^2}$	No. 8 = $\sqrt{4a^2+8b^2}$
No. 9 = $\sqrt{5a^2+9b^2}$	No. 10 = $\sqrt{5a^2+10b^2}$

As will be seen, these distances increase at a certain rate from squad to squad, viz., if we always add 2 distances (1 + 2, 3 + 4, 5 + 6, &c.)

each two will increase by an equal space, so that we have here a progression which, if the number of squads is an even one (equal to the terms of a progression), would increase at the same rate from squad to squad, even if we had several hundred or any even number of squads. In this progression the first term, A, is equal to the distance between the first squad on the ditch and the portion of the dike assigned to it $(=\sqrt{1a^2+1b^2})$, and the last term, U, is equal to the distance between the last squad and their portion of the dike $(=\sqrt{5a^2+10b^2})$, and the number of all the terms of the progression n is equal to the total number of squads (in this case 10), from which results the above formula for ascertaining the sum total of the distances along which the earth has to be carried. This progression will be interrupted as soon as we take an odd number of squads (equal to the terms of the progression), because, as has been shown, the progression is only produced by adding the distances of each two squads. In order to use the formula given for progressions when we have an odd number of squads (if we could not use the calculation by progression we would have to find the distance of each squad, as was done for the 10 squads; these would have to be added, which, however, would be a very tedious work if the number of squads was large, and would, moreover, easily give rise to errors in the calculation owing to the long rows of figures), we must consider the last but one squad as the last term of the progression; we would then have to find the sum of this progression, to which would have to be added the distance of the last squad, in order to get the sum total of the distances of all the squads.

Supposing we have an odd number of squads, say, instead of 10, 9, we would get the following distances:

$$\begin{aligned}
\text{1st squad} &= \sqrt{1a^2+1b^2}\\
\text{2d squad} &= \sqrt{1a^2+2b^2}\\
\text{3d squad} &= \sqrt{2a^2+3b^2}\\
\text{4th squad} &= \sqrt{2a^2+4b^2}\\
\text{5th squad} &= \sqrt{3a^2+5b^2}\\
\text{6th squad} &= \sqrt{3a^2+6b^2}\\
\text{7th squad} &= \sqrt{4a^2+7b^2}\\
\text{8th squad} &= \sqrt{4a^2+8b^2}\\
\text{9th squad} &= \sqrt{5a^2+9b^2}
\end{aligned}$$

the sum of which, S, the first squad being A, and the last even one u (here 8), and the final odd squad Z (here 9), and the number of even squads n (here 8), would be as follows:

$$S = \frac{n(A+u)}{2} + Z.$$

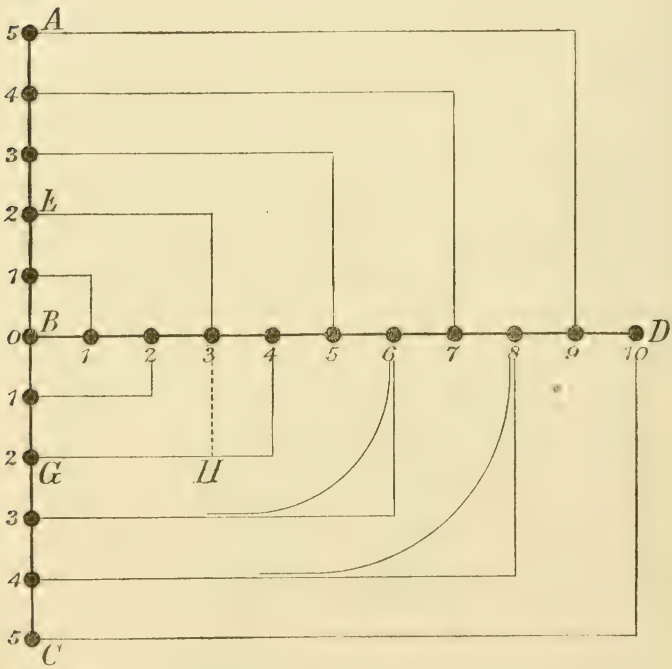
After having in this manner found the sum total of all the distances, the next question will be to find the number of shovelers required. This is found by dividing the sum of these distances by the distance which a laborer can conveniently throw the earth in a horizontal direction, *i. e.*, 3.6 meters.

It will be better, however, to divide by 3.5, as in this way a distance will be over, for which, if it is too great to be divided among the shovelers, another shoveler should be engaged, which will be an easy matter. The necessary number of shovelvers, Sh, for removing the earth will be found by the following formula:

$$\text{Sh} = \frac{\text{S}}{3.5} = \frac{n\,(\text{A} + u)}{7}$$

2. We have now to speak of the second method of placing the laborers.

Fig. 7.



Leaving the fish-pit for the present out of our calculation, the same formula will have to be used as in 1, for getting the sum total of all the distances and the required number of shovelers. All we have to ascertain are the distances over which the first and the last squad will have to remove the earth to the dike.

The length of each of the individual distances has been given here only for the purpose of showing the progression.

As will be seen from the figure, the individual distances of the parts of the ditch from their corresponding points along the line of the dike will—presuming the part of the dike assigned to a squad to be a and the part of the ditch assigned to a squad b—be as follows:

Squad 1 on the ditch $= 1a + 1b$
Squad 2 on the ditch $= 1a + 2b$
Squad 3 on the ditch $= 2a + 3b$
Squad 4 on the ditch $= 2a + 4b$
Squad 5 on the ditch $= 3a + 5b$
Squad 6 on the ditch $= 3a + 6b$
Squad 7 on the ditch $= 4a + 7b$
Squad 8 on the ditch $= 4a + 8b$
Squad 9 on the ditch $= 5a + 9b$
Squad 10 on the ditch $= 5a + 10b$

We have here another progression, and it will, therefore, not be necessary, as has been done in this case for the sake of illustration, to ascertain the length of each part, but it will be sufficient to ascertain that of the first and of the last squad, no matter whether the number of squads is a hundred or any other number. The formula for this has already been given under 1.

3. The same applies to the curved lines. For our present purpose I deemed it proper to choose the straight lines, because they will make the method of calculation more intelligible.

For 2 and 3 the same formula will, therefore, have to be used as for 1, in order to find the necessary number of shovelers, and what has been said there with reference to an even or odd number of squads will likewise apply here.

If the fish-pit, E F G H, is to be dug at the same time, the first terms, 1, 2, 3, 4, representing the squads working the parts 2—2 of the dike, would be dropped from the above progression, because they and the corresponding part of the ditch would be worked by the squads assigned to the fish-pit, which would also dig the portion of the ditch between 3 and 4, as soon as they do not need it for their arrangement, and the number of squads N, which would have to be used for ascertaining the number of shovelers, would now be 6 instead of 10, and the first term for calculating the progression would be the 5th term, *i. e.*, the distance assigned to the 5th squad. The placing of the laborers for the fish-pit is done parallel with the dike on line F H, which may be divided among 4 squads working in the same manner as the rest of the squads; for every distance exceeding 3.6 meters an additional shoveler should be employed.

The fish-pit is dug out in the same manner as a large ditch. The formula for ascertaining the total number of laborers required for constructing a dike with the necessary ditches, will, on the basis of the formula given above for finding the number of laborers, excluding, how-

ever, the special shovelers for any distances exceeding 3.6 meters, be as follows, (sh being the number of shovelers required for the fish-pit):

$$A = \left(\frac{La}{l} + Sh + sh\right)$$

But as the fish-pit runs parallel with the dike, and consequently the line of the work has also to be run parallel with it, the number of shovelers for each squad will be the same; and if F stands for the number of laborers required for the fish-pit, L for the portion of the dike alongside of the fish-pit, *a* for the number of laborers per squad, and *l* for the distance assigned to each squad, the formula will be:

$$F = \frac{La}{l}$$

which formula will be needed, if, for special reasons, the fish-pit is to be constructed after the main ditch and the dike, which, however, cannot be recommended. In this case it should not be forgotten, in the first calculation of the number of laborers (exclusive of the special shovelers referred to several times), to omit the portion of the dike which is bordered by the fish-pit. The fish-pit, and the portion of the dike belonging to it, may also be calculated separately, as well as the rest of the dike and the ditches belonging to it; in this case the number of laborers found for each should be added, and in this way one would get the number of laborers required for the entire dike and all the ditches.

If it is intended to commence work along the entire line of the dike with a certain given number of laborers, and to push the work to completion in all its parts, the length of a piece, *l*, should be ascertained, which should be worked by one squad, according to the following formula:

$$l = \frac{LA}{A} + Sh + sh$$

and, accordingly, each squad should be assigned that length of ditch which will furnish the necessary quantity of earth for the allotted length of dike.

In order to find the time in which, with the greatest possible or any given number of laborers, the dike can be constructed, all that is necessary is to calculate the cubic contents of a portion of the ditch which has been assigned to a squad, which will supply the demand of a corresponding piece of the dike, and to divide this by the cubic contents of a piece of the ditch removed in an hour, or in a day, and the quotient will be the number of working hours or days.

In the example given as an illustration the most favorable case was supposed, viz., that the main ditch, of equal length with the dike, would supply earth for the entire dike, that, therefore, the earth removed from the portion of the ditch assigned to each squad is equal to the cube of

that portion of the dike which they strike. If the ditch is not so large it will be advisable to construct as much of the dike as can be completed with the earth supplied from the ditch. In this case it would be necessary, if one divides the line of the dike into parts measuring 1.2 meters each (greater distances should be avoided, as otherwise the pounders would be too far apart to pound sufficiently the newly heaped-up earth), to calculate the cube of each of the above-mentioned parts, and from this the length of ditch to be assigned to each squad, so as to make sure that the cubic contents of the length of ditch will supply the necessary quantity of earth for the corresponding portion of the dike, in which case, therefore, the squads working along the ditch will have longer distances assigned to them than those working on the dike. The same principle is observed as regards the distribution of labor on the other portions of the dike and the ditches supplying the material for the same. It is known from experience that one man, if the soil is tolerably easy to work in, can remove 450 cubic decimeters of earth in one hour; if the soil is sandy, 600; and if it is difficult, 300. This applies also to an entire squad of laborers, as only one of their number removes the earth from the ditch, the others being employed in carrying it farther and leveling it.

The carrying of earth in wheelbarrows should, as much as possible, be avoided, as it takes more time than throwing it; this difference is not equalized by saving some men for throwing the earth, and this method is consequently more expensive. Wheelbarrows should be employed only when a sufficient number of laborers cannot be obtained, or in cases where the distances between the ditch and the dike are very great. A wheelbarrow holds on an average 21 cubic decimeters of earth, and two men can in one hour dig out 450 cubic decimeters and load them on the wheelbarrows. One man can in twelve working hours travel over an even road 28 kilometers (with wheelbarrow, coming and going). If we let w stand for the distance traveled, the cubic contents, K, of the quantity of earth removed in one hour by a wheelbarrow will be ascertained by the following formula:

$$K = \frac{21.21.2000}{36\,w + 350} \text{ cubic decimeters,}$$

and the number of men at the wheelbarrows, A, for every two men digging and loading the earth will be:

$$A = \frac{(36\,w + 350)}{7.\ 7.\ 40.}$$

For a distance exceeding 1 kilometer it may be advisable to employ carts. A cart with two horses can carry 450 cubic decimeters of earth, and, on an even road, travel 28 kilometers in twelve hours. For every loading and unloading a loss of seven minutes should be counted. In going uphill the distance traveled should be increased by four times as

many meters as 30 centimeters is contained in the difference between the even and the uphill roads. In going downhill the same rule applies as on an even road. The above, of course, only applies to horses; if oxen are employed only 0.7 of these figures should be counted. The cubic contents, K, of the earth to be removed in one hour is:

$$K = \frac{450.\ 7000}{6\,w + 4900} \text{ cubic centimeters,}$$

and in order to ascertain how many carts or wagons, W, are required to remove the quantity of earth dug out by two men in one hour the following formula will have to be used:

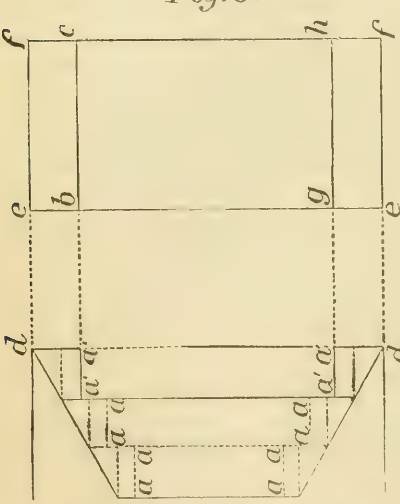
$$W = \frac{(6w + 4900)}{7000}.$$

We now have to speak of

THE CONSTRUCTION OF THE EARTH-WORKS.

In constructing large ditches, such as the main ditches and those for letting the water in and out, it will be found a great aid in constructing their walls or sides to dig out perpendicular steps 30, 60, and 90 centimeters high. These steps should vary in breadth from 15 to 60 centimeters; their breadth, however, will greatly depend on their height and on the angle of the slope. Only those on which laborers are to stand must at least be 90 centimeters broad. The perpendicular sides *a a* of these steps (see the figure) should be distant about 15 centimeters from the proposed walls of the ditch, so that these may not be damaged. The breadth of the first step, carried inward from the terraced level edge of one of the sides of the ditch, supplies the end points for the line *b c*, along which the laborers are to be placed, and the same principle applied to the other side of the ditch supplies the line *g h*, the limits of the first prism *a′ a′ a′ a′* to be dug out. In order to accelerate the work it will be advisable to mark with pegs the piece assigned to each squad of laborers. The laborers are placed, according to the direction (either right or left) of the lines of work from the ditch towards the dike, in such a manner as to place one squad on the line *b c*, and the next on the line *g h*. Before the shovelers can be employed to move the earth farther,

Fig. 8.



every squad along the ditch should have piled enough earth at a distance of 3.6 meters, to give work to one shoveler, and as soon as it has been moved another 3.6 meters to another shoveler, and so on till the earth is brought to the edge of the sole of the dike on the land side. In constructing small ponds the piling up of the earth and the consequent placing of the shovelers will progress so rapidly that there will be no need of temporarily finding other employment for these shovelers. In large ponds they may, unless employed in digging the foundation of the dike, temporarily engage in some other work, *e. g.*, the digging of another ditch, and whenever needed they may be called on to aid in the construction of the dike. But even in the case of large ponds the time till the shovelers are needed at the dike will be very short; if, however, the number of these shovelers is large, an unnecessary expense would be incurred by letting them stand idle, even for a short time. After all the shovelers have been set to work in removing the earth towards the dike, and every squad is, therefore, complete, it will be found (if the calculation has been correct as to the nature of the soil, the outlines of the piece of ground to be worked, and the distances for which the earth has to be carried) that one shoveler, seconded by a proportionate number of men with pickaxes, will dig out and throw the earth the distance assigned him, one man will level it and pound it, and the other shovelers will be engaged in moving it from one point to the other.

As regards the pounders, it will be best to place several in a row, because if each one pounds at some distance from the other the earth will escape on all sides. If there is any scarcity of rammers, the different layers may be trodden down by the laborers; but as in that case one man would not be sufficient to attend both to the leveling and pounding, it will be found advantageous to supply the necessary number of rammers, one to each man. After the first prism has been dug out, work is commenced on the second, and so on till the sole of the ditch is reached. The deeper one goes the slower will the work progress, because the earth will have to be thrown not only in a horizontal but also in a vertical direction.

In case the scarfs of the dike are not to be covered, as much good earth as possible should be used for the outer coating. This earth should be piled up beyond the outer edges of the boards indicating the outlines, and should here be particularly well pounded and beaten together with broad and heavy pieces of wood. During this whole process the earth should be sprinkled a little. When this has been done the scarfs are, with the shovel, made as smooth and exact as possible, which adds greatly to their firmness, as the water is not apt to do as much damage to a smooth wall of earth as to one intersected by large and small furrows. If the dike is to remain uncovered, it should under all circumstances be planted with willows. If the sides are to be covered, one leaves a distance of 45 to 60 centimeters between the earth-work and the ropes indicating the outline, and does not begin to cover the dike

until it has reached one-half or three-fourths of its height, so that during the rapid progress of the work of covering it there may always be sufficient earth for filling out. We shall below give directions as to the various methods to be followed in covering a dike. After the ditch has been dug out in its rough outline, furrows are cut in the steps in those places where the profiles of the ditch, lengthened upwards, have been drawn, in the same direction as these profiles. Thereupon the boards are lengthened downward, the wedge-shaped pieces of earth are removed with a spade, and finally the walls of the ditch are made as smooth and accurate as possible. The earth obtained by this process is used for completing the dike; if it should not prove sufficient it may be advisable to enlarge the ditches and the fish-pit. If even then the quantity of earth should not be sufficient it should be obtained from other places.

If the dike is to be built of a soil which consists only of one layer of good earth, and for the rest is composed of sand and stones, this layer should be taken off and piled up along the edge of the foot of the scarp on the water side, so as to serve as an outer coating, while the stones, &c., may be used for the inside. In this case it will always be necessary to obtain some earth from another locality. If the dike is to be placed on sloping ground it should have a very firm foundation, so that it cannot easily slide down. If the slope is very steep a sort of step should be dug out for the foundation, and if the slope is gentle, only a hole 20 to 40 centimeters deep; but, even in the latter case, the step referred to may answer the purpose. In the former case, trenches 50 to 60 centimeters broad are dug along the entire length of the proposed dike at intervals also of 50 to 60 centimeters, so that a small piece of the original soil remains between the different trenches, and the earth of the dike may, so to speak, be dovetailed with the original soil. No special laborers need be employed for preparing the foundation of the dike; this should be done by the shovelers and pounders during the intervals of their labor until they can be employed in removing the earth, and until a sufficient quantity of earth is piled up near the dike to begin with the leveling and pounding.

B.—*Covering the dike.*

In order to give the greatest possible firmness to the dike, the earthwork is surrounded with a coating of more solid material. This coating is particularly needed on the water side, and, if it is in any way possible, it should not be omitted on that side, which should also be planted with willows. If good earth has been employed this coating may be omitted on the land side, but even here it will prove an advantage. The land side should also, under all circumstances, be planted with willows.

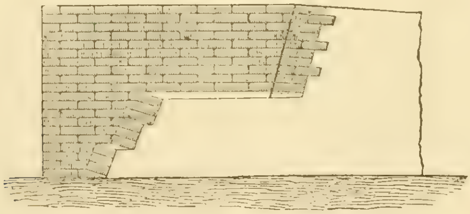
The dikes are covered either with 1, sod; 2, fascines; 3, wickerwork; 4, earth; or 5, wood.

1. *Sod.*—For this purpose there will be needed pieces of sod 30 centimeters broad, 30 to 45 centimeters long, and 10 to 15 centimeters thick,

For the corners, pieces of sod 45 centimeters broad and long are used. These pieces are obtained by the simple process of cutting or digging. In order to work dry sod advantageously it is sprinkled for several days before it is cut. It will be still better, however, to leave this work to nature, and not to begin digging until rain has sufficiently moistened the sod. The best sod is that which has a dense growth of short fine grass on a dark soil, while sod from a very moist or sandy soil is not good. Sod removed from a very moist soil will, when deprived of its natural moisture, soon wither and die; and sod from a sandy soil will fall to pieces when it is handled. Sod taken from a damp soil would thrive, when used on the water side, if the pond was filled with water immediately upon the completion of the dike, which, however, cannot be done, as one generally gives the dike a year's time to settle and become solid. After the place where the sod is to be cut has been marked off in suitable squares it will, if the sod is easy to cut, take three and, if difficult, five men to cut 2,000 pieces in twelve hours. This work had best be done in the following manner: One man inserts the spade to a depth of 10 to 15 centimeters, while two assistants, by a vigorous pull, strip off the sod, whereupon the first man lifts it out entirely and lays it on the ground with the grassy side downward. It is true that this work might be done by one man without any assistants, but in that case he will be able to supply in twelve hours only about one-fifth or one-sixth of the number of pieces which 3 men can supply. If possible no more pieces should be cut at a time than can be used up in one day, so that they may not dry out. If the supply on hand cannot be used up in one day, the remainder should be piled up to the height of 60 to 100 centimeters, and, if the weather is dry, be thoroughly sprinkled in the evening. The pieces of sod are carried in hods, similar to those employed for bricks. Such a hod will hold eight to ten pieces, while a common wheelbarrow will at most hold six.

The covering of the dike is done in the following manner:

Fig. 9



All the pieces, with the exception of the topmost layer, are laid down with the grassy side downward, so that their broad sides stand perpendicularly on the wall formed by them, and no seam comes to be over another one. The pieces composing the lowest layer are placed entirely in the ground. The pieces should join closely, and if the wall is to be scarped, extend to the outermost edges of the boards forming the profile,

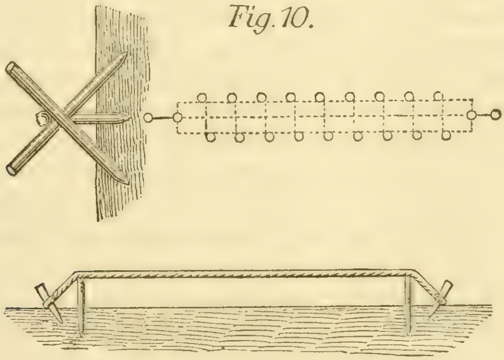
otherwise only to the inner edges of the same. In order to give greater firmness to the corners it will be advantageous to use for them larger pieces, about 45 centimeters square, by laying them alternating, with the ordinary pieces (30 centimeters square). Each layer is carefully smoothed down and the empty space in front of it filled with earth, which is rammed down. The uppermost layer is laid with the grassy side upward, and every layer is fastened with one or two pegs 30 centimeters long and 4 centimeters thick. After this has been done the wall is scarped and smoothed down, which, however, will not be necessary if the pieces of sod have been carefully laid. In order to make the connection between the covering and the earth-work of the dike stronger every third layer may be double, when the front pieces should be cut 10 centimeters (as shown in the figure), or larger pieces should be employed. A squad of three men, one of whom carries the pieces of sod, while the second lays and fastens them, and the third fills the spaces between the earth-work and the covering with earth and rams it down, can use 2,000 pieces in twelve hours.

The dimensions of the walls which are to be covered, and those of the pieces of sod, whose thickness will be only 7 to 10 centimeters even if they have been dug out from a depth of 10 to 15 centimeters, will determine the entire amount of pieces of sod required, to which should be added 10 per cent for those which cannot be used. The length of wall which can be covered in one hour is calculated by dividing the number of layers required for the entire wall by the number of pieces of sod (160) which can be laid in one hour, and the quotient is multiplied by the length of that side of the piece of sod which comes nearest the wall. This way of covering a dike with sod is called the head-sod covering. One may also, but only in case of very gentle slopes and wherever very solid soil can be obtained, cover the walls, after they have been scarped, with pieces of sod in such a manner that every piece lies with the grassy side upward, and in order to make this covering still more solid every piece may be pinned down with two pegs. It will be easily understood, however, that this mode of covering will not be near as solid as the one described above. The first-mentioned method should be employed in all cases where there is no solid earth for the outer sides of the earth-work and where it is impossible to obtain material for wicker-work. If instead of the pegs referred to shoots of willows can be used, the willow plantation will have been provided at the same time. Most of these shoots will thrive. If there are not enough of them to supply both the land and water side of the dike, they should only be used for the latter. Willows should likewise be planted along the foot of the dike.

2. *Fascine covering.*—The most solid covering, and that which can be made in a comparatively short time, is that by fascines. By fascines we understand cylinder-shaped bundles of dry sticks, tied very firmly, measuring at most 5.4 and at least 3 meters in length and 25 to 30 centimeters in thickness. If there is a sufficient quantity of material in the

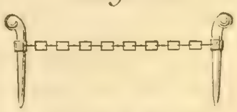
neighborhood these fascines can be prepared rapidly, and if there are enough willows near by, they are to be preferred to any other kind of covering. If there are not enough willows, the branches of poplars, alders, hazel bushes, birches, &c., may be used. If the number of willows is not sufficient to supply all, or at least one-half, of the fascines, one may alternately place one row of willow fascines and a row of those made of other material, or in making the fascines the willow branches may be put on the outside and the others inside. If the willows will not suffice for this, it will be advisable to use wicker-work for the covering of the dike. The branches or sticks used for fascines should be as long as possible and not more than 5 centimeters thick. For tying the bundles thin willow branches will be best, and if these cannot be obtained, thin branches of wild grape-vines, birches, and hazel bushes. It will in every respect be found advantageous, if possible, to manufacture the fascines in the place where the material is found. For making fascines, so-called fascine benches will be needed. For making these benches, which, as shown in the figure, should first be marked off by pegs, there will be required 18 pegs, measuring 6 to 8 centimeters in thickness and 175 centimeters in length, and 18 bands to tie the fascines.

Fig. 10.



In arranging the pegs, which cross each other, they should, especially if the ground is soft in the beginning, be placed almost perpendicularly, and be gradually inclined till they reach the rope stretched at a distance of 30 centimeters above the ground. At the place where the pegs cross each other they should be very firmly tied with willow branches or fastened with nails. Six men can make at least 30 pegs in twelve hours, if they are to be cut from solid wood, and a great many more if thin branches are used. For making fascines a squad of five men needs one pair of fascine pinchers (see the figure), one fascine knife, one stick of the same length as the fascines are to be (one will be sufficient for three squads of laborers), one short and thin stick 30 centimeters long, for measuring the distances between the bands, a thin switch, easily bent, for ascertaining the thickness (25 centimeters) of the fascines,

Fig. 11.



and a piece of wood, shaped like a two-pronged fork, for putting on the bands. The necessary quantity of sticks should, of course, be on hand, and 18 bands per fascine. Of these bands an extra supply should, however, be kept on hand, as many of them will tear; and if the work is to progress rapidly, a large quantity of bands should be on hand when the work commences. With the exception of those made of wild grape-vines and willows, they should all be heated before the fire and twisted a little, so as to make them tough. At their thin end they should have a loop. In order to make the fascines of equal thickness, *i. e.*, in the shape of cylinders, a bundle of sticks, with all the thick ends together towards the outside, is placed on the fascine bench; and thus one continues to lay bundles of sticks along the entire length of the bench in such a manner that the thick ends of one bundle are always over the thin ends of the next. Sticks are piled on until, by measuring the circumference with the above-mentioned pliable switch (for which purpose the fascine pinchers should also be used), one finds that the necessary diameter has been reached. In tying the fascines, two men press the sticks outside of the first cross together (with the fascine pinchers) in such a manner that the ends of the measuring switch, applied close to the place where the pegs are tied, lap over a little; a third man thereupon catches the bundles with the band in the same place, and in such a manner that he can draw its thick end downward through the loop, places the fork-shaped piece of wood on the loop, presses it with one foot, draws the band downward (when drawn upward it generally tears), twists it, thereby forms a sort of screw, and finally sticks the thick end of the band among the branches of the fascine. The fascine pinchers should be drawn off gently, because otherwise the band might easily be broken by the rebounding of the sticks of the fascine. In this manner all the 18 bands are put on, at intervals of 30 centimeters, all the screw-like portions (see above) being in a straight line, so that when the fascines are fastened to the earth-work of the dike they all may be on the inside. The next thing to do is to cut the fascine vertically 15 centimeters from the first band; from this point one measures 540 centimeters and cuts the fascine again, the fascine pinchers being put on the fascine outside of the saw with which the cutting is done, and finally the fascine is trimmed and cleaned of all protruding branches. If the bands are good, a laboring squad can easily finish a fascine 540 centimeters long in one hour. For transporting such fascines two men will be needed for short and three for long distances. If the roads are in good condition, a two-horse wagon can carry eight such fascines.

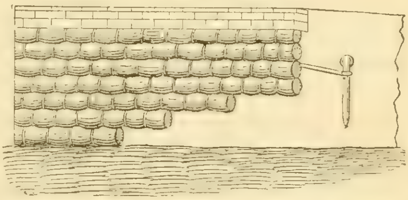
For the purpose of covering the earth-work of a dike with fascines, there will be needed for pinning them down thick pegs measuring 60 to 90 centimeters in length, and 7 to 10 centimeters in thickness. Six men can easily make 1,000 such pegs in one hour. There are also needed pegs with hooks, measuring 1 meter in length and 5 to 7 meters in

thickness; of these the same number of men can make only 500 per hour.

The bands which are to serve for fastening the fascines must be very strong and long, and have a loop at each end. To every hooked peg one should count two such bands.

The fascines, which are close to the ground, should be entirely inserted in it, and all the screw-like pieces of the bands should be on the inside. This bottom layer of fascines is, at intervals of 30 centimeters, fastened to the ground by pegs measuring 60 to 90 centimeters in length. The other layers are pinned to the earth-work of the dike at intervals of 60 centimeters, with pegs 1 meter long (by the aid of these figures the whole number of pegs needed may be calculated). No succeeding layer of fascines should be pinned to the earth-work, until the empty space between the preceding one and the wall of the dike has been filled with earth well rammed down, nor should any of the places where one fascine joins the other be above another such place. Every third layer should be firmly anchored by means of pegs and bands at intervals of 2 meters. It will, therefore, be easy to ascertain the entire number of pegs and bands to be used for this purpose.

Fig. 12.



The fascine covering should be carried only to such a height as to leave room for from 25 to 30 centimeters of earth, which should be well rammed down. If there are any pieces of sod, at least two layers of these should be placed on the topmost fascine before the earth is put on. This is necessary in order that the cover may not project over the edge of the crest, when the earth begins to settle after awhile.

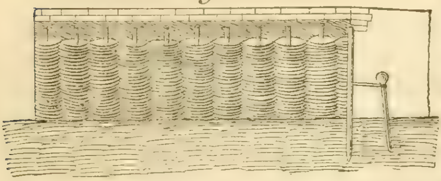
A squad of five men, with one mallet, one spade, and one rammer, can easily lay, pin, and anchor 21.6 meters, *i. e.*, 4 fascines measuring 5.4 meters each, in one hour. Some men should be ready with saws, for sawing off the fascines, if necessary. In a dike running in a straight line this will, however, be necessary only at the ends. By pinning, the fascines lose at least 25 millimeters of their diameter, which circumstance should be taken into consideration if the length of wall is to be calculated which a laboring squad can cover with fascines in one hour. L standing for this length of wall, and a for the necessary number of layers of fascines for a given height of wall, the thickness of the fascines being 22.5 meters, and the consecutive meters of fascines to be laid in one hour being 21.6, the following will be the formula:

$$L = \frac{21.6}{a\ 0.225}.$$

3. *Covering of wicker-work.*—To cover dikes with wicker-work involves but little trouble. This method, however, can be employed only in small

dikes with a height of wall of 1 to 2 meters, as with a greater height the mass of earth would exercise too great a pressure on the weak wicker-work. Whenever this method is employed in higher dikes their height should be broken by several terraces. The material for wicker-work is, of course, branches, those of the willow tree, whenever obtainable, to be preferred, because they will save the special planting of trees, as such wicker-work will soon grow and have numerous shoots. If willow branches cannot be obtained, the branches of poplars, alders, birches, &c., may be used. The branches should be long and slender, and 2, at most 3, centimeters thick, so that they can be twisted round the sticks without any trouble. Very thin branches would have to be plaited like the wicker-work of baskets, which would delay the work and make it more expensive. One man with a hatchet can in twelve hours cut enough branches to form 17 square meters of wicker-work covering. The sticks for the wicker-work should be 5 to 8 centimeters thick and project 60 centimeters above the wicker-work, and should, if possible, be taken from willow trees. If these sticks are to be cut from the solid wood, six men with the necessary tools can make 300 of them in twelve hours; if, however, young stems or branches of sufficient thickness can be used, this will be a great saving of time and labor.

Fig. 13.



Hints as to the manufacturing of the hooked sticks and bands have already been given above under the heading of the fascine covering. Laths or poles will be required for connecting the sticks, about 2.15 meters to every 2 consecutive meters of wall.

The covering of the dike with wicker-work is done in the following manner: The sticks are driven into the ground, at intervals of 30 centimeters, to a depth of 45 centimeters, and to prevent their being pulled out of position during the plaiting of the wicker-work they are at their tops connected by poles or laths. The wicker-work should enter at least 10 centimeters deep into the natural soil. As in fascine-covering, the wicker-work is made about 25 to 30 centimeters lower than the dike. In order to accomplish the work in the shortest possible time one should proceed in the following manner: The branches are laid down along the entire line of the dike at a distance of one pace. One man commences to plait at one end by laying the individual branches alternating inside and outside the sticks. If the branches are too thin several should be formed into a bundle. After the first man has proceeded 5 to 6 paces, a second one commences to plait, to be followed at a similar distance by the third and last man. In this way the work will progress rapidly, one man driving the other. The anchoring may, in dikes measuring 1 meter in height, be done in the middle; and in dikes measuring

2 meters at one-third and two-thirds of the entire height, at intervals of 1.8 meters. Double anchoring is done somewhat on the model of a chess-board. If, *e. g.*, at one-third of the height the 1st, 6th (or 7th), and 12th (or 13th) sticks have been anchored, this is done at two-thirds of the height with the 3d (or 4th), 9th (or 10th), and 15th (or 16th), &c. After the wicker-work has been carried to the necessary height the last three or four branches are, at intervals of 1.8 meters, tied to the sticks with bands, and finally earth is piled up over the wicker-work to the height of 25 to 30 centimeters and rammed down; or, as shown in the figure, two or three layers of pieces of sod are fastened to the dike. A squad of three men, supplied with the necessary tools, can ram in 300 sticks in twelve hours. A squad of five plaiters needs a fascine knife, a spade, and a mallet; and after the sticks have been driven in the ground they can finish 2.5 square meters of wicker-work in one hour, three men doing the plaiting, while one man fills the space between the wicker-work and the dike with earth, and another one carries the branches.

4. *Earth-covering.*—This consists of a cover of earth 45 to 90 centimeters thick, which serves as a coating for a dike composed of loose soil. Clayey or loamy soil will be best suited for this purpose. This covering is made by piling up layers 15 to 20 centimeters high of soil carefully freed from all stones. Every layer is well rammed down, and, if the weather is dry, it is sprinkled. In order to have the earth-work connect thoroughly with the covering, it will be well to ram down the covering in the shape of steps. For a length of dike of 1 meter, one man with a rammer will be needed, and to every 24 rammers, one man with a sprinkler. In this manner the earth-covering will progress at the rate of about 30 centimeters per hour. Earth-covering can be used only when the slope of the dike is very gentle, the base of the slope being equal to the entire height of the dike; and if one is compelled to employ this method of covering, the slope of the dike should be made to accord with it. This covering should be sowed with grass seed or planted with willows, by simply planting young shoots. Horak says in regard to this: "Among the willows the common basket-willow is the best, as it will thrive in a loose, moist soil, and is well adapted to wicker-work and fascines. One-year-old shoots, 20 to 30 centimeters long, should be used, putting seven-eighths of their entire length in loose soil and only allowing one-eighth to protrude. The beds where these shoots are to be planted should be hoed in a breadth of 20 to 30 centimeters and to a similar depth, and the shoots should be planted just as one plants young vegetables. If these shoots are well watered during dry seasons they will grow to the height of 50 to 70 centimeters during the first year. If the shoots are simply stuck in a hard soil the bark and the germ are destroyed, and the plantation will prove a failure."*

If the earth-covering is planted with willows immediately after its completion it will, of course, not be necessary to hoe the soil, as it will

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* *Deutsche Fischerei-Zeitung*, 1878, No. 21.

be sufficiently loose, and all that is necessary will be to make holes in the ground for receiving the shoots In old dikes and wherever the earth has settled and become hard the hoeing should never be omitted.

5. *Wood-covering.*—This method consists in ramming in piles about 10 centimeters thick at intervals of 1 meter along the water side of the dike. These piles should be square, and back of them strong boards are placed, whose edges must fit closely together. They may also lap over a little, but in that case more boards will be needed. The places where the boards join should not be one over the other. These boards are nailed to the posts, which, in order to render them more durable, are generally made of oak wood. Both the posts and the boards should be covered with tar or creosote. Such wooden dikes, as they are called, should not rise perpendicularly on the water side, but must likewise slope somewhat, the base of the slope to be at least one-sixth of the height of the dike. Wood-covering, however, should be employed only in case of urgent necessity, *i. e.*, when no other material for covering the dike can be obtained, for it is not only very expensive, but it is also the least durable kind of covering, and requiring constant repairs.

C.—*Stone dikes.*

Unless constructed of square pieces of stone fitting closely together, stone dikes are the least practical of all dikes; but if constructed in this manner they will be so expensive as to prevent the laying out of the pond altogether. Dikes composed of earth and stones mixed will have the least firmness, because the water will easily work a way for itself between the stones. Such dikes must have a covering. Dikes composed of a large number of irregularly shaped stones, placed closely one upon the other, will still let the water pass through. The walls of the dike, at any rate on the water side, should therefore be well built with mortar and cement. Large stones, however, may well be used for filling out the dike, if there is enough binding earth to cover it, especially on the water side. But, wherever a firm dike is needed, and where it is impossible to construct an earth dike with any of the coverings described above, it will be safest to build along the water side a strong wall with a slope towards the water, and supported on the back by stone pillars. Back of this wall the dike is constructed of stones and sand as firmly as possible. Such a dike should be very broad, so as not to be pushed back by the wall (against which danger the pillars afford some, but not absolute, protection), and of corresponding height, so that during freshets the water may not overflow it and carry away the back part, *i. e.*, the dike proper. To make such an occurrence absolutely impossible, it will be necessary to build a similar wall also on the land side. In cases where the ditches furnish only gravel and sand for the construction of the dike it will not be advisable to lay out a pond, for the bottom of such a pond would not supply sufficient and suitable food to the finer kinds of fish, especially the carp, and would not hold

water. The case will be different if the bottom of the pond has a layer of good earth on the top, then sand below this good earth, and below this sand good earth again. Neither wood nor stone dikes will then be necessary, but a dike made partly of earth and partly of sand and gravel, covered with one of the coverings described above, will answer the purpose.

D.—*Fascine dikes.*

These dikes are made of fascines in the following manner: A layer of fascines is placed along the entire breadth of the sole in the natural soil, and fastened in the ground at intervals of 30 centimeters, with sticks or pegs measuring 60 to 70 centimeters in length. The next layer of fascines is placed crosswise over the first, the next lengthwise, the next again crosswise, and so on until the dike has reached a proper height and shape. Great care should be taken that the seams of the fascines are not one above the other. Every layer is anchored, like the fascine covering, at intervals of 2 meters, and each individual fascine is pinned to the one below with pegs measuring 1 meter in length at intervals of 60 centimeters. Each layer is well filled with sand or gravel before the next layer is put on. Such a dike should have a gentle slope, and the walls, as well as the crest, should be covered with good earth (if possible) to the depth of 25 centimeters and well rammed down. If the outer fascines are made of willow branches there will soon be a growth of young willow shoots. Fascine dikes are very durable, but they require an enormous quantity of branches, and if there is a lack of binding earth, the covering will also have to be fascines or wicker-work.

No rules can be laid down as to the material for building the wall and constructing the covering, as this will have to be determined in each case by the local circumstances, especially by the degree of firmness which the dike needs in proportion to the size of the pond and the mass of water rushing against it; and, in the second place, by the building material at one's disposal. In a work like the present we can only point out the advantages of one method over the other, leaving to the pond culturist the choice of the methods, according to his peculiar circumstances; and it is not supposed that, in a case where wicker-work answers all purposes, he will choose the more expensive fascine covering, even if he should possess all the necessary material therefor.

2. THE MAIN DITCH.

This ditch should cross the entire pond in a straight line from the place where the water enters to its outflow. As it will be found advantageous to have all ponds so constructed as to allow the wintering of fish, the main ditch should, wherever the given quantity of water permits it, be at least 1.5 meters deep. The width of the ditch at the top will be determined by the base line of the slope; if the slope is gentle, it will be

wide, and if steep, narrow. The question whether the slope is to be more or less gentle will depend on the quality of the soil from which the ditch is dug, whether it is firm or loose. The grade should also be taken into consideration. The steeper the grade the gentler should be the slopes of the walls of the ditch. In very loose soil the base line of the slope should be twice the depth of the ditch, in medium soil 1.5 of the depth, and in clayey soil equal to the depth. The breadth of the sole may be made to correspond with the quantity of water and the size of the pond; it will be advisible, however, in case the quantity of water in the ditch is as a rule moderate, but rises considerably at times, to make the sole very broad, and dig out from it a small ditch corresponding to the average depth of water. In small ponds, where it is not intended to winter fish, the main ditch may be less than 1.5 meters deep, and its other dimensions should be made to correspond with this depth. If there is a sufficient supply of water, a depth of 1.5 meters will be ample for wintering fish, and if the grade of the pond is very steep, and the greatest height of the water above the bottom of the pond is more than one meter, it will be well to diminish the depth of the ditch by this excess of height over 1 meter. The main ditch, as well as all the other ditches, should be carefully constructed, so that along the entire length the upper width and the breadth of the sole remain the same, and the slope is even and smooth throughout, as otherwise there is danger of their being washed out.

3. THE SIDE DITCHES.

In order to drain the pond and lay it dry, small side ditches will be needed, which end at the banks. Their number will depend on the size, location, and nature of the pond. Muddy and mossy ponds, containing many reeds, will require more such ditches than ponds with a firm bottom, which are free from such obstructions. They should invariably fall towards the main ditch, for they are not only intended, whenever the pond is drained for fishing, to compel the fish, as the water recedes, to fly to them, and thus to carry them to the main ditch and ultimately to the fish-pit, but they should also lead the water by the shortest possible way to the main ditch, and through this to the outflow. When the ponds have been laid dry and planted, they are to serve as receptacles for the rain-water, and as channels through which it can flow off quickly. During the fisheries they are also intended to enable the fishermen to penetrate into the thickets of reeds, and drive into them all fish which may have remained in these thickets, so that they may ultimately be carried to the fish-pit. In large ponds the main ditch and some of the side ditches should be broad enough for a boat to pass through them. The grade of these ditches should be the same, so that the fish do not remain scattered throughout the side ditches, thus making fishing difficult.

If there are many depressions in the bottom of the pond, ditches should be constructed from these to the main ditch, in order to cause

the fish to enter them, and allow the fishermen to approach these depressions for catching the fish hiding in them. In ponds containing a great many reeds the side ditches are also to serve as roads by which the fish may easily reach their feeding-places near the banks, and as places of refuge in all parts of the pond, where they may find safety from birds of prey and other enemies of fish. Their construction and maintenance should therefore keep all these purposes in view, and they should be kept clean at all times. After the ponds have been laid dry, and the fisheries are over, special attention should be given to the cleaning out of mud from these ditches.

4. THE FISH-PIT.

In order to drain a pond completely and catch all the fish contained in it, the fish must be gathered within a narrow space, where they have water enough to prevent any suffering during the fisheries. For this purpose it is necessary to have a depression near the place where the water flows off into which the fish may gather when the pond is drained, and from which they can easily be taken with nets. This depression is called the fish-pit. When the pond is being drained, the fish, as the water recedes, seek the deep water of the ditches, and through these they enter the fish-pit. The fish-pit will best be formed by widening the main ditch either on one side of the ditch, as we generally find it in old ponds, or extending it equally on both sides, which will probably be the more practical way.

The fish-pit should be kept as clean as possible of mud, and it will therefore be advisable to line it with wood. This should only be omitted in ponds which have a very firm bottom and but little mud. The fish-pit of those ponds, however, which are to serve as spawning ponds should be lined with wood, unless the bottom is very clayey and firm, so that it may be possible to take out all the young fry. The fish-pit should be entirely free from stones, bushes, reeds, &c., so that the fish may not hurt themselves during the fisheries and during wintering, and likewise to prevent any tearing of the nets. After every fishing season the fish-pit should, therefore, be carefully cleaned. If the fish-pit is only to serve for fishing purposes, its depth need not be very great, but in order that the water may be let off entirely, and the pond may be cleared of fish, its bottom should be higher than the outlet pipes. If the fish-pit is intended also for wintering fish, its depth should be great enough to prevent the freezing of the pond in winter, and it should be at least 2 meters deeper than the greatest depth of water elsewhere in the pond.

In order to gain some means of determining the approximate size of the fish-pit, we will state that one generally counts 800 cubic decimeters of water to 100 pounds of carp; but it will in all cases be advisable to count double this quantity, especially when the fish-pit is to serve as a wintering place, or when there is a possible lack of water during the

fisheries. Fish of prey, like pike, &c., need a still greater quantity of water and consequently a still larger fish-pit. As not only the success of the fisheries, but also the safety and well-being of the fish during winter, depends on the proper construction of the fish-pit, it should be carefully constructed and kept scrupulously clean.

5. THE OUTSIDE PIT.

In order to catch those fish, which, in spite of all precautionary measures, such as grates, nets, &c., escape through the outlet pipes, a depression corresponding to the fish-pit should be constructed on the land side of the dam, where the water leaves the outlet pipes, so that the fish may be gathered and caught in it. This depression is called the outside pit. It should be closed against the outer outlet ditch by a narrow grating. This will be all the more necessary if below the main pond there are spawning or growing ponds which are fed from it, so as to prevent fish of prey from entering them. The grating is not only intended to prevent the food-fish from escaping, but also to retain small fish which are used for feeding the fish of prey in the main ponds or tanks. The outside pit should always have a depth of water sufficient to keep the pipes under water, as only thus will they last for centuries, while, laid dry and exposed to the air, they will soon decay. The size of the outside pit will be regulated by the size and location of the pond, as well as by the quantity of fish it is expected to hold. With large ponds the outside pit is generally a square hole in the ground lined with wood.

6. DITCHES FOR THE SUPERFLUOUS WATER.

Whenever streams or brooks pass through a pond, it will be necessary to place a weir with locks in these streams or brooks, so that the necessary quantity of water may at any time be let into the pond, while the superfluous water must be carried away through ditches. This will be necessary particularly in mountain streams, as during heavy rains they will carry a great deal of gravel, small stones, and mud, which would soon obstruct the pond. Such waters should be caught outside the pond, or the weir, in the ditches which carry it round the pond, so as to join the stream again below the pond. The ditches for the superfluous water should be of sufficient breadth and depth to receive the quantity of water which may be expected, They should be carefully constructed, as irregular sides are much more exposed to the destructive force of the water than smooth ones. For better protection it will be well to plant the sides with willows. Wherever the tap system is employed, the outlet pipes are, after the water in the pond has been raised to its normal height, closed by a tap, which is not drawn till the fisheries commence, unless special circumstances should require it. In small ponds, whose supply of water is, as a general rule, small, and at times interrupted—as is specially the case with sky ponds—it will be necessary, in order to keep the water at its normal height, that a suitable means of escape

should be furnished to the water, somewhere along the bank, usually near the point of the dike. This is likewise done by ditches which receive and carry away all the superfluous water from the pond and the surrounding cultivated land. These ditches, of which a large pond should have several, must at their starting point near the bank be closed with grates, so that no fish can escape through them. Such ditches also become necessary, where, after violent rain storms, or by the melting of the snow in spring, there is danger of inundations. To receive and carry away the water from such inundations, ditches should likewise be constructed in suitable places.

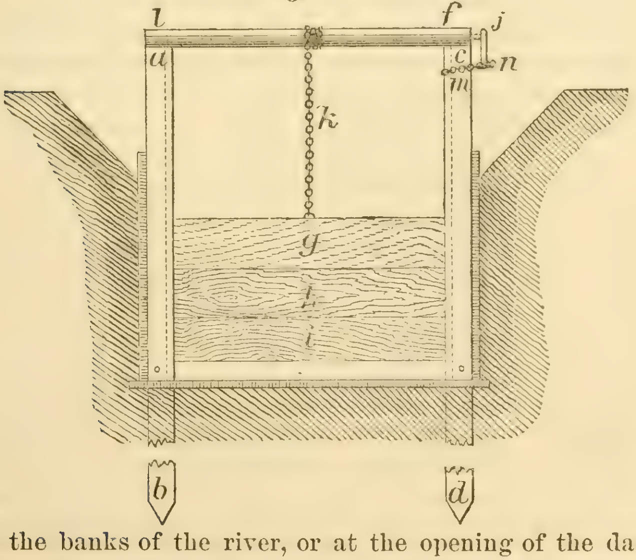
7. ARRANGEMENTS FOR LETTING THE WATER IN AND OUT.

A.—WEIRS WITH LOCKS (SLUICES).

The feeding ditch receives its water either, *a*, from a river or brook; *b*, from one or several springs; *c*, from rain or snow water (as in sky ponds); *d*, from other ponds.

a. A pond may be fed by a river or brook, either by having a portion of its waters led into it through channels, or by causing the entire stream to pass through the pond. In both cases it will be necessary to put a weir, with locks, at the place where the water enters, so that the supply of water may be properly regulated. In the first case, the water pursues its natural course in the bed of the river; and, in the second case, *i. e.*, where the weir is placed in the stream itself, the water has to be led in ditches round the pond to rejoin its original stream below the same. In both cases a narrow grate should be put at the place where the water enters the pond, so as to keep out intruders, especially fish of prey. Such weirs are constructed in the following manner:

Fig. 14.



Along the banks of the river, or at the opening of the dam (when the brook or river passes through the pond), strong wooden posts, *a b*

and *c d*, are rammed in, and connected by a cross-beam of equal strength, *l f*. The opening should be tolerably wide, especially where much water flows into the pond. The bottom should be covered with strong pieces of wood, or with masonry, up to a level with the average height of the water. On this foundation rest strong movable boards, *g*, *h*, *i*, which should fit so exactly in grooves in the posts that no water can pass through. The two posts *a b* and *c d* must be so firmly connected with the dike, or with the banks of the stream, that the water cannot possibly force a passage between the posts and the sides of the dike. Instead of making grooves in the two posts *a b* and *c d* two posts may be placed on each side so close together that the spaces between them form grooves for the boards. In that case the posts should be so close together that no water can pass between them and the boards. The lowest board should fit exactly in a groove in the strong beam on which it rests. It will, of course, depend on the accuracy with which all this work is done whether the flow of the water can be properly regulated. The foundation beam, with its groove, should always be secured by iron clamps, so as to resist any pressure of the water. If one board is not sufficient, another one, or several, one above the other, should be used. Suitable contrivances should be connected with the cross-beam *l f* for raising and lowering the boards. The easiest way to do this is to make the cross-beam in the shape of a roller, as shown in the figure, or to place a roller immediately below the cross-beam. The roller and the boards are connected by a chain, *k*, so that by turning the roller by means of the lever *j* the boards can be raised or lowered. When the boards have been raised to the desired height, the lever is fastened to the post *c d* by the chain *m*, and secured in its position by a padlock, *n*, so that the arrangement cannot be tampered with. If the weir is very broad, it may be well to ram down in the center one or two posts of equal strength with the side posts, and use only short boards, which run in the grooves formed by these center posts. These short boards are easily raised and lowered and may be recommended because the water can be more easily regulated by them, as it will not be necessary to open the entire weir. In order to give firmness to the whole, strong posts should be laid close together at the bottom of the weir, and reach up to the first board. In order to prevent the water from washing out the holes underneath the weir, and thereby forcing a passage (which might easily happen if the weir was placed directly upon the ground), the ground below the weir should be covered for a length of 2 to 2.5 meters, or more, with strong posts and boards forming a firm floor, so that the superfluous water may easily flow off along this floor. Such weirs are, especially in large ponds, the safest and simplest means of regulating the water.

If it is impossible to carry off the superfluous water of a brook or stream passing through a pond by means of outside ditches, it should be allowed to flow in over a weir, so as to direct it towards the exit by the shortest road, so that the fish may not be disturbed or carried away by it. It

will always be found advantageous to have smaller or larger weirs, according to the size of the pond and the quantity of water which flows into it, as they are, after all, the best means of regulating the supply of water. It will, under all circumstances, be advisable to keep the sluice-gate under lock and key, so that it cannot be opened by mischievous persons. This can be done in a very simple manner by a lever which holds the boards in position, and which is locked to one of the side-posts.

In large ponds it may become necessary to construct canals through the banks and dikes for the supply and exit of the water, generally in very steep places. Such canals should be very carefully constructed, so that no damage may be done to the bank or dike, and experts should be engaged for the purpose. Such canals may also be needed in ponds which have weirs, so as to supply still more outlets for the water, to decrease the force of the stream passing through a pond, or to carry off the water from remote portions of the pond, for which purposes weirs will not always suffice. For draining the pond for the purpose of fishing, there are conduits or pipes underneath the dam, through which the water may flow out. They fully answer this purpose, for weirs or sluices are not so practical in this case, as their management is always connected with some difficulty.

b and *c*. The supply of water from springs and, in sky ponds, from the atmosphere, will never be so large as to make it a matter of indifference whether this supply is constant, or whether there is, in sky ponds, anything to prevent the free entrance of rain or snow water; but as a general rule these means of supplying water need no special regulation. Weirs are therefore not needed, and all that is necessary will be to put a grate at the place where the water enters freely, but which prevents the fish from escaping. Any superfluous water may be carried off through outside ditches or be led to the lower pond or ponds.

d. A lower pond (or ponds) is filled from a higher pond by simply letting the water flow to its destination through pipes, until the desired height of water has been obtained, when the tap is driven in again. The supply of water coming in during the course of the year reaches the lower ponds through the outside ditches of the upper ponds, until a full supply is obtained, and the superfluous water is carried off through other outside ditches. All that is needed to regulate the water flowing through these various ditches will be to put grates in them at suitable places.

B.—Water-pipes.

To drain a pond for the purpose of fishing two means may be employed, viz., taps and stand-pipes. For both these methods pipes are needed. These pipes are laid horizontally through the dike. They should lie 15 to 20 centimeters deeper than the bottom of the pond, or rather of the fish-pit, in which they open, so that they can receive all the water. To prevent the water from flowing out too near the dike, whereby it

might be damaged, the pipes should extend 2 or 3 meters into the pond, and project about 1 meter on the land side. When laid, the pipes should be well enveloped in clay on all sides, so that the water may not force a passage by the side of them; for this will always be the place where there is danger that the water may escape from the pond. These pipes are made of the trunks of trees which are split in half and hollowed out; another half trunk, likewise hollowed out, is used for the upper portion, or lid; as soon as the lower one has been laid, the upper one is placed on the top of it. They should, of course, fit accurately. For this purpose a layer of fine moss is made, carefully cleaned of roots, branches, stones, &c. Such pipes can hold a good deal of water, and are, especially in large ponds, the safest means of supplying an exit for the water. If made of sound pines felled during winter, they will last for centuries, provided that they are constantly kept under water. As the laying of the pipes always necessitates the digging up of the dike, durability should of course be the first consideration; for this labor involves many inconveniences and considerable expense. The width of bore of these pipes should be regulated by the size of the pond, so as to allow the water to flow off in a suitable period of time. As a rule, however, the bore should not be wider than 30 centimeters, particularly as the water is apt to widen it in course of time. In large ponds there should be two, three, or more of these pipes, which should be laid at such distances from each other that for the purposes of repairs one of them can be dug up without interfering with the others.

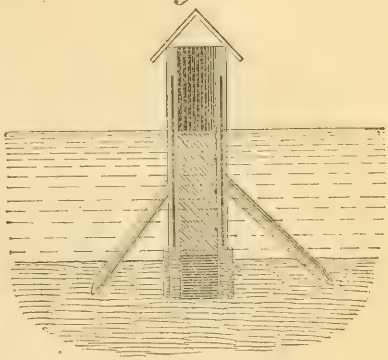
In small, remote ponds, which are apt to be visited by fish-thieves, the openings of the pipes should be narrow, so that the water cannot flow off quickly. and requires more time than fish-thieves generally have at their disposal; for it will of course be easier to steal fish from a pond which can be drained in four to six hours, therefore in one night, than from one which takes from twelve to twenty-four hours.

C.—The stand-pipe.

This consists of a second pipe placed vertically on the exit-pipe. This pipe is likewise made of a hollow trunk which is open on one side, where grooves run along its edges in which small boards can be inserted, and easily removed. The vertical pipe should project somewhat over the dike, so that the pond may be filled to any desired height. According to Jokisch, vertical pipes are also employed which are only as high as the average height of water in the pond (especially in ponds which have a constant supply of water). Such pipes are left open at the top, so that the small boards reach as far as the other sides of the pipe. The upper square opening is covered with a grate, so that the water when it rises above its normal height may flow off without carrying any fish with it. The same author says that a better contrivance of a similar character may also be connected with the common vertical pipes. They are allowed to rise as complete pipes (not halved), and only a little above

the high-water mark they are cut down, so as to form a point resembling a roof, and small boards or pieces of tin are nailed to the top, so as to prevent it from rotting. The small boards should fit accurately so that as little water as possible may ooze through; and all cracks should be well closed with a mixture of clay and fine-cut straw, and covered with tar and sand. Where there is danger that ice may press against the vertical pipe, it will be well to drive some piles in front of the pipe, so as to prevent the ice from loosening the small boards.*

Fig. 15.



Delius says: "The exit-grate needs some arrangement to raise the water which flows through it, to any desired height, and cause it to flow out, for on this depends the regulating of the height of water in the ponds. In large ponds only one vertical pipe can be used. With grates having projecting sides, the vertical pipe is placed on the foundation-beam and firmly connected with it, as well as with the top of the grate. The open side is turned towards the pond, and each side has a groove in which are inserted small close-fitting boards corresponding to the height of the water. Only above these boards can the water of the pond flow off, and by inserting them, or taking them out, the height of the water can easily be regulated. The space between the sides of the pipe and the corner posts is closed by pieces of wood. At the back the pipe has an opening in which is inserted a small pipe intended to carry farther the water coming from above. The space round this small pipe is filled up with clay well rammed down. A still simpler arrangement, but only suitable for small ponds, is the so-called monk. Instead of the foundation-beam a long pipe is laid through the dike, so as to project on both sides; with this pipe is connected a vertical pipe, also with grooves and small boards inserted in these. If this monk is allowed to project far enough into the pond to make it difficult to reach it from the shore, it will not be easy to damage it, especially if the water is deep."†

According to Horak, vertical pipes are employed to advantage where small brooks pass through a pond, and where it is desirable to keep the water at an even height. The topmost little board is, so to speak, the indicator of the normal height, and all the superfluous water will easily pass over it. The pond may be drained gradually by removing one little board after the other till the bottom is reached.‡

I am inclined to prefer the stand-pipe, both in large and small ponds,

*Jokisch, *Handbuch der Fischerei*, 1804. (Manual of Fisheries.)
†Delius, *Teichwirthschaft*, pp. 87, 88.
‡Horak, *Teichwirthschaft*, 1869.

to all other methods of carrying off the water, not only because it is self-acting in keeping the water at a level even at times when the supply of water is superabundant, thus rendering outside ditches unnecessary, and because the draining of the pond can thereby be easily managed and regulated, but also because the change in the height of the water, when the supply is scanty, can readily be recognized by it. When the water falls one can, so to speak, read its height on the stand-pipe, for which purpose it will be well to make the little boards all of one and the same height and number them; and as it is important for the pond culturist to be able to find the different causes of the varying productiveness of his ponds, he will be aided in this by the stand-pipe which will enable him to ascertain at once the height of the water. Stand-pipes will, therefore, be of special importance in sky ponds.

D.—The tap-exit.

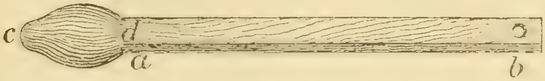
This consists simply in placing a suitable piece of wood, called the tap, in the opening where the stand-pipe, described in the preceding chapter, joins the exit-pipe. In small ponds short, and in large ponds long, taps are used. Tscheiner says regarding short taps: "The short tap, which does not protrude above the surface of the water, will prevent thieving, and deserves special mention. It is about 60 to 70 centimeters long and shaped exactly like the lower portion of a common tap. After it has been firmly inserted in the hole, some centimeters, both in depth and breadth, of the wood are removed from the top, which is covered with a broad piece of iron having a long and narrow hole in the center. For drawing the tap a so-called key is necessary, consisting of a cross-shaped piece of iron, which must fit in the hole. To the other end of the key a pole is fastened. If several small ponds are to be closed by a short tap, the holes in the taps should be all of the same size, so that they can all be opened with one key. To open a pond closed in this manner, seek the hole with your key; as soon as found, insert the key; turn it half around, and thus lift the tap from the water. This can, of course, only be done in small ponds, when the taps are not large, and consequently not very heavy. In very small ponds, where diminutive taps are used, it will be sufficient to make at the top of the tap a small notch, in which, when it is to be drawn, the so-called pond-hook is inserted."

It should be observed that these contrivances for drawing a short tap will not suffice for drawing it out entirely, as it has to be driven in very firmly in order to keep the arrangement water-tight. It will therefore be necessary in all cases to loosen the tap by knocking it several times, when it can be taken out without the aid of any special contrivance. If the method described above is to be employed, it should not be forgotten to give the iron on the top a coat of paint to keep it from rusting. At the moment when the tap is drawn, a piece of wire-work is inserted in

the hole. A grate should be put in front of the exit, or it should be surrounded by a standing net.

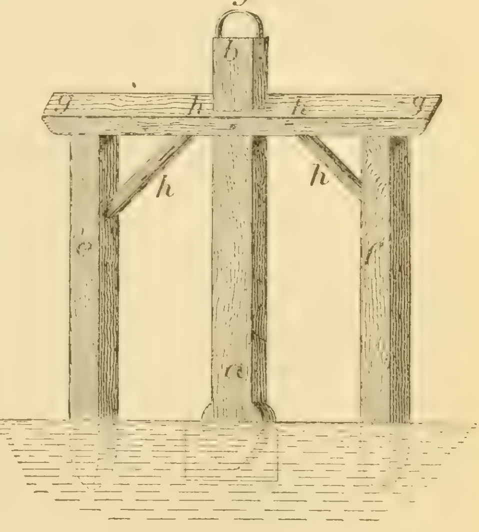
In great ponds where the pipes are large, and where the tap closing them is correspondingly large and heavy, it consists of a piece of solid

Fig. 16



wood, about 3 meters long (if the pond is very deep, still longer), the lower part of which is formed by the tap. In order to insert and draw this tap, the following contrivance will be necessary:

Fig. 17.



On both sides of the exit opening strong posts, *e f*, are driven in, which at the top are connected by an equally strong cross-beam, *g g*, and, in order to make the structure still stronger, are further connected by two braces, *h h*. In the center of the cross-beam there is an opening, *h h*, through which runs the tap-pole, *a b*,* and which when the tap is inserted projects about 30 centimeters above the cross-beam. The head of the tap-pole is covered with iron, in which a strong iron ring is firmly inserted and fastened with screws. All the iron-work is painted, to prevent it from rusting. Where the tap-pole passes through the cross-beam a strong screw is driven in, so as to prevent mischievous persons from drawing the tap. If there are several such tap contrivances, it will be well to have all these screws of the same size, so that they can be drawn by one and the same screw-driver. Whenever the tap is to be drawn, a strong pole is passed through the ring, and by moving this pole up and down (which operation requires three and sometimes more men), the tap is loosened and finally pulled out. In large ponds such contrivances are, on two sides, surrounded by a stone or wooden wall, so as to protect them against waves and ice. This wall is not continued on the side towards the pond, but is here replaced by a grate to prevent the fish

* These figures, with their explanations, are often obscure or in error. For instance, in Fig. 17, *h* means two different things.—EDITOR.

from escaping through the exit-pipes into the outside pit, whenever the tap has been drawn and the pond is being drained. In small ponds it will be sufficient to surround these contrivances on three, and sometimes on four, sides with grates; or even omitting these, to place simply a standing net in front of them during the fishing season. This, however, will be advisable only when a very short tap is used. Formerly the entire contrivance was sheltered by a roof, and has from this circumstance retained its name, "tap-house." If this tap-house is placed far out in the pond, it is connected with the dike by long boards which answer the purpose of a bridge. Of late years the tap-houses in large ponds have been built of stone and masonry. Horak says, regarding the advantages and disadvantages of such tap-houses, as compared with wooden ones:

"On the Wittingau estate a beginning with stone tap-houses was made in 1831; and since that time the old wooden tap-houses are, instead of being repaired after the spring floods at a great expense, replaced by new and solid ones built of stone. They are not only to be preferred because there is a saving of lumber, but also because they offer many other advantages. In the first place they are better able to resist the winter storms, and the floods and ice of spring, and they very seldom need repairs; the outlet pipes are not placed upright, but inclined at an angle of 40 degrees, and are protected by a solid stone covering. In the old wooden tap-houses the front was occupied by a grate; that portion of it which was under the water could, of course, easily resist any hurtful influences, while the portion above the surface, owing to the changes in the weather, would soon decay, and frequently be destroyed by the waves and by masses of ice pressing against it, which of course would cause the fish to escape into the tap-houses, and thence into the outside pit. It is now customary in stone tap-houses to have the grates entirely under the water; these grates resemble square cages, which, back of the scarf of the wall, are inserted in the bottom of the pond, and can be seen only when the pond is entirely drained. It cannot be denied, however, that stone tap-houses also have their disadvantages. As these stone tap-houses require the tap-pole to be in a vertical position, it will be necessary, in building a tap-house, to drive a shaft in the scarp of the dike down to the pipes, and there make an opening to admit the tap. The entire structure becomes more erect, is moved closer to the terrace of the dam, and is connected with it in such a manner that the new tap-house only forms a sort of projection on this terrace.

"Among the disadvantages of stone tap-houses we must also mention the following: During very cold weather the tap-poles will freeze in the water, and as there is no possibility, as in the old wooden tap-houses, to get at the opening of the pipe, it will be necessary, whenever water is to be drained off during the winter, to heat the lower wall near the opening in the pipe, until the ice melts and the tap can be drawn. Iron

grates are not practical. It has happened that through oxidation iron grates became so obstructed that openings had to be forced with strong poles, during which operation some of the bars of the grate were generally broken, and, to prevent the fish from escaping, the holes in the grates had to be stopped with fascines. Wherever iron grates have been employed they are gradually being replaced by wooden ones. When stone tap-houses were first built iron taps were fastened to wooden poles, which, however, did not prove a practical arrangement, because it frequently happened that the iron taps remained in the pipe, and only the poles were drawn, which, of course, necessitated laborious and expensive repairs. Although the stone tap-houses are liable to cause peculiar difficulties, the pond culturist should not thereby be discouraged, but he should endeavor to improve these tap-houses in every possible way, because, on the whole, they are far preferable to the old and cumbersome wooden boxes."*

E.—The grates.

All the exits of a pond must be so arranged that the water can flow off easily, without giving the fish any chance to escape. For this purpose grates are placed not only at all the exits, but also at the placés where the water enters the pond, for it is well-known that fish like to go against the stream.

Delius gives the following description of the grate:

"It is a wooden grating, the bars of which are placed vertically, and which is close enough to keep the fish from passing through, while it

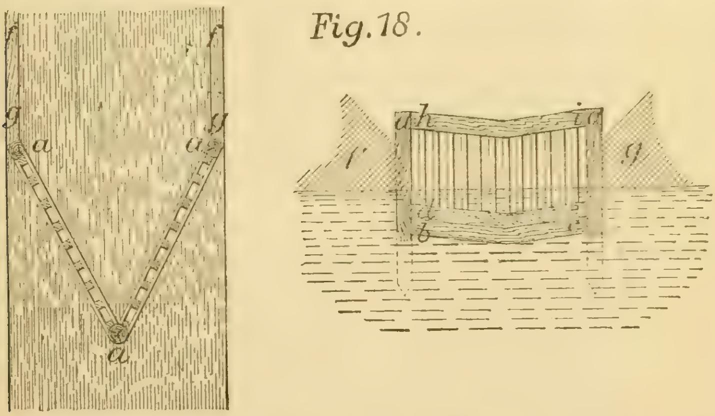


Fig.18.

offers an unobstructed passage to the water. The size of the spaces between the bars depends upon the size of the fish which are in the pond. The following is the construction of the grate: On both sides of the ditch strong posts, *a a*, are driven in; between these posts another ditch is dug, across which beams, *b c*, are firmly laid; on the top of this

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* Horak, *Teichwirthschaft*, 1869.

wooden foundation another cross-beam is laid, *d c*, in which the bars are inserted. The upper one of these two cross-beams is firmly joined to the side posts. The space in front and back of the foundation is filled with clay, which is rammed down firmly and smoothed on the top. On both sides of the posts a wooden wall, *f g*, is placed. The beams forming the foundation are on a level with the bottom of the ditch, while the wooden wall has about the same height as the average level of the water. Several feet above the surface of the water a cross-beam, *h i*, connects the two posts. The space between the foundation and this cross-beam is occupied by vertical bars which are inserted in holes in the cross-beam and in the foundation."* It will be found exceedingly practical to have two such grates meet at an angle, so that they can better resist the pressure of the water, and let more water pass through. Wherever the pressure of the water is not very strong a simple grate will suffice.

III.—FILLING THE POND WITH WATER.

After the pond has been constructed in the manner described above, and after the dike has been allowed to dry and become firm, the pond can be filled with water. In filling a pond two questions have to be considered, viz.: 1. How is it to be filled? and 2. At what time?

1. HOW FILLED.—When the pond is to be filled, all the exits have to be closed up, the taps are firmly driven into their places, and the tap-pole is screwed to the cross-beam. All crevices round the tap are carefully stopped up with moss or clay, so that there is no possibility that the water can enter the pipes. Earth may also be piled up round the tap, and rammed down firmly, but if the tap is short, the place should be marked, so that it can easily be found when the pond is to be drained. At the stand-pipes the little boards are placed in their grooves and screwed to them. If it is noticed that, in spite of all precautions, water oozes through in some place, it will be necessary to construct a dam of earth and sod round the place; for even if the quantity of water which oozes out is very small in the beginning, such places will gradually widen and do great damage to the dike and the pond, by decreasing the water at a time perhaps when every drop is needed. This case is particularly liable to happen in carp ponds which remain stocked for two or three years. All these precautionary measures should be taken before the pond is filled, and some little time should be allowed to pass, so the work may become firm. After all this has been done, the places where the water enters are thrown open, and the desired quantity of water is let in.

2. WHEN FILLED.—The usual times for filling ponds are spring and autumn. It will depend on the use to which the pond is to be put after the fisheries have come to an end, which of these two seasons is to be selected. If the pond is to be stocked with fish before winter sets in,

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* Delius, *Teichwirthschaft*, p. 87.

it should be filled in autumn. If it takes a long time to fill a pond, which is the case with large ponds, especially those whose supply of water is scanty, and still more with sky ponds, which are entirely dependent on rain and snow water, it will become imperative to fill the pond soon after the autumn fisheries. The necessity for filling a pond in autumn, which might have been allowed to lie dry during winter, may sometimes arise from the circumstance that the water is needed for other purposes besides the fisheries, *e. g.*, to drive mills or to form a supply in case of fire. The time for filling a pond will, of course, also depend on the quantity of water which can be disposed of.

If none of the above-mentioned circumstances render it advisable to fill the pond in autumn it will, as a general rule, be well to let it lie dry during winter, and not fill it till spring. Thereby it will become possible to make necessary improvements in the pond, to repair the dikes, clean the ditches, level rough places on the bottom of the pond, remove injurious plants and superfluous mud, and to hoe the bottom, so as to expose all its parts to the influences of the atmosphere, which makes it healthier for the fish and better calculated to produce worms, other fish-food, and useful aquatic plants. Young fry of fish of prey found in the spawning and raising ponds may be destroyed, the number of frogs may be diminished, &c. It will be seen that the advantages connected with letting a pond lie dry during winter are so great that no pond which is not to be stocked with fish in autumn, nor a pond whose supply of water allows it to be filled at any time, or which can easily be filled in spring before it is stocked with fish, should be filled in autumn. This is all the more necessary if the pond has been stocked for two or more consecutive years, as owing to the lack of atmospheric influences the bottom will cease to yield the necessary supply of fish-food. This will make itself particularly felt in those ponds which have to produce their own supply of fish-food; and less in those ponds which receive much water from cultivated fields and meadows, or are entirely dependent on this mode of supply; as, for example, the sky ponds. On the other hand, such ponds are more liable to accumulate an excessive and injurious quantity of mud.

As regards those ponds which remain filled for two years, Teichmann says that his experience has taught him that it will be advantageous not to give them their full supply of water during the first year. He states that during summer one entire side of these ponds was used as pasture close to the water's edge. On these dry places the cattle deposited their excrements, and it was certainly beneficial for the fish to expose these places to the fresh air during an entire summer. After more water was let into the pond in the second year, the fish undoubtedly found an abundant supply of food in those places which had remained dry during the preceding year. This experience appears to make it desirable, under certain circumstances, especially in large ponds which remain filled for more than one year, which are shallow and have no high banks,

not to admit the full supply of water at once. If the circumstances are such as to allow the water to be admitted and let out at any desirable time, and if it is not intended to fill the ponds immediately to their full height, stand-pipes are to be preferred to tap-houses. Taps cannot be drawn until it is desired to drain the pond entirely, because, in ponds of any size, it will be difficult again to drive them in firmly and make them water-tight. With stand-pipes it is possible to fill a pond to a certain desired height, and to let the superfluous water flow off through the stand-pipe.* A pond which is not entirely filled during the first year should receive a quantity of fish corresponding to the filled portion, and not to its whole area, and it will be doubtful whether the relative increase in the weight of fish will be the same as if the pond had received its full stock of fish. More will be said on this subject under the head of stocking the ponds.

IV.—Fish-culture.

As has been said above, pond culture comprises both the raising of fish (fish-culture) and the keeping of fish. Local circumstances, such as the number and size of the ponds, their location, the nature of their soil and water, &c., will determine the manner in which pond culture is to be carried on. In some places, therefore, fish-culture and the keeping of fish will have to be combined, while in others these two branches of pond culture will have to be carried on separately, in order to derive the greatest possible income from a certain given area of water. Without fish-culture, however, pond culture will always remain incomplete. The keeping of fish, without fish-culture, means only to use a pond according to its locality, nature, and local circumstances.

A.—*Carp-culture.*

Fish-culture may extend to several kinds of fish, but, as a general rule, pond culture relates exclusively to the culture of the carp. From an economical point of view the carp must be considered as one of the most important food-producers, as it destroys no valuable food-matter, its food principally consisting of products of nature which could not find any other use, and of the refuse from the human household; as it is easily satisfied as regards the nature of the soil and water; as it is a very hardy fish, which can easily be raised almost anywhere; and as it grows rapidly, has a fine flavor, and everywhere finds a large and ready sale.

Systematic pond culture requires at least four ponds: 1, a spawning pond; 2, a raising pond; 3, a stock pond; and 4, a winter pond. These four kinds of ponds are absolutely necessary for systematic fish-culture.

The *spawning pond* is needed because the spawn and young fry, if placed in ponds with larger fish, could not be sufficiently protected against numerous dangers. The young fry should, therefore, be in

* Teichmann, *Ueber Teichfischerei*, 1812, p. 40.

small ponds by themselves, so that the proper care and supervision can be exercised. It would, of course, be possibly to carry on carp-culture in a large pond in such a manner as to let the carp spawn there and grow up there until they become marketable. In this case the full-grown fish would be caught every year, but their number would not be very large, nor could they always be obtained at the right time. This method, therefore, is only excusable when a person possesses only one pond. In that case it would hardly be proper to speak of regular systematic pond culture, and it would be advisable to confine himself to the keeping of fish. In cases where only one pond can be cultivated all that will be obtained will be the leavings of the pike. By keeping the young fry in ponds especially adapted to their needs (spawning ponds) the greatest possible quantity of young fry may be looked for with absolute certainty, and when these young fish have grown sufficiently to be transferred to larger ponds there is reasonable hope that they will thrive, because they have become strong enough to avoid dangers, and are moreover not exposed to as many dangers as the young fry.

Young fry of one summer cannot immediately be placed in the large main or stock ponds, as these, in order to answer their full purpose, have to be stocked with other fish besides carp, especially with fish of prey, *e. g.*, pike; and even if this was not done intentionally, it would be exceedingly difficult to keep such ponds entirely clear of fish of prey. It is, therefore, necessary to have other ponds, in which the young fry can be raised and grow strong enough to be transferred to the stock ponds; and these ponds are the *raising ponds*. But since, as a general rule, the young fry have, during the second summer, not yet become strong enough to escape the dangers which threaten them in the stock ponds, another raising pond, No. 2, will be needed. If it is impossible to have this second pond, nothing remains but to place the young fry of two summers at once in the stock ponds, and let them remain there three, or at least two, years, which, as will be shown later, is not advantageous.

After the third year has been completed—I always count in the spawning year—the young fry have grown large and strong enough to share a pond with other fish, and they can, therefore, be transferred to the *stock ponds*. In the stock pond the fish are allowed to remain one or two years, *i. e.*, until they have reached a weight of at least 2 pounds apiece, and have thus become marketable.

As only in very rare cases the spawning and raising ponds are of sufficient depth and of a character to permit the wintering of the fry and young fish, a fourth pond will be needed, which is of sufficient depth and has the requisite supply of water to prevent the fish from freezing during winter. In this pond the fry and young fish can be put in autumn, so that they can pass the winter with absolute safety. Such ponds are called *winter ponds*.

These are the most necessary ponds for carrying on systematic fish-

culture, more especially carp-culture. It will be self-evident, however, that fish-culture and the keeping of fish can be carried on more successfully if one has a larger number of ponds. The smaller the number of ponds—even if they are of large size—the more unreliable will fish-culture be, as it will be impossible to guarantee to the fish that degree of safety which they require at different ages. A complete pond culture, therefore, requires a large number of ponds, which will not only make it possible to raise carp systematically, but will also offer an opportunity to raise other fish, as trout, pike, &c. Not only every kind of fish, but every age, needs different circumstances and surroundings to insure success. Not all ponds have the same soil, the same natural conditions, the same water, depth, size, &c., but they differ in these respects, and fish-culture must take into account these differences, if it is to be carried on systematically and successfully. It will, therefore, be necessary to know which ponds are best adapted to certain purposes, and we shall have to examine what experience teaches relative to the selection of ponds for the various purposes of carp-culture.

1. SPAWNING PONDS.

The spawning pond is the most important of all the ponds, for it forms the basis of the entire pond culture. On the production of a suitable quantity of young fry of the proper quality the success of pond culture will principally depend, and great care should, therefore, be exercised in selecting the spawning pond.

The following are the requisites of a good spawning pond: A spawning pond should not be very large; it should lie on a level, and be exposed to the sun the whole day; for water sufficiently heated by the rays of the sun is the main condition not only of beginning the spawning process in due season, but also of its ultimate success, as well as of the hatching of the eggs. Ponds fed by springs should therefore be avoided. Spawning ponds should not be shaded by trees; but on the side which is most exposed to the wind they should be protected by woods or hills, because strong waves occasioned by wind are injurious to the spawn, and are apt to throw the young fry on the banks, where they will perish. It must be considered as particularly favorable if on the north and east side there are hills or buildings which reflect the rays of the sun on the pond. Spawning ponds should be shallow, because this favors the heating of the water, and their depth should decrease towards the shore. They should be crossed by a suitable number of ditches, so as also to afford to the fish deep and cool places. Their depth of water should never be less than one meter, so that there is no danger of their drying out in summer. Spawning ponds should not only be drained during winter, but they should also be planted the year previous, not only to remove acids from the soil, but also to make sure that there are no pike in it. This method also drives away the frogs, which destroy much spawn. In order to make sure that there are no

pike in the spawning pond it should in spring be filled by rain or snow water, *i. e.*, if possible, be a sky pond. It should not connect with brooks and rivers, as in this way other fish, especially pike, may get into the pond. For the same reason spawning ponds should not draw their supply of water from other ponds. If it is impossible to fulfil any of these conditions, the grates should be very narrow, and, if possible, double. It is under all circumstances advisable to substitute in spawning ponds for the grates sieves of copper wire or perforated boards. The fish-pit of spawning ponds should be of sufficient depth to allow the young fry to winter in it. If during the summer the fish-pit is covered with vegetation, this should be removed with a sickle attached to a long handle before the beginning of autumn, so that the young fry may find a clean resting-place during winter. Reimann insists that all spawning ponds should have a fish-pit, *i. e.*, a place deeper than the rest of the pond, where the fish may gather during winter, and where during summer they may find a cool place of refuge.*

Horak says: "The young fry of the current year should not be caught during autumn of the same year, because they are exposed to many dangers, and even to total destruction; only in the exceptional case that the fry cannot winter in the spawning pond, it may be justifiable to catch them. This should, however, be done with great care, before the fish reach sexual maturity."† In all cases, no matter whether the young fry remain in the pond during winter or not, the fish-pit should be lined with wood, so to prevent any loss of young fish while they are being caught.

The following should also be observed: The spawning pond must contain some stones, and in some places aquatic plants, because the female fish like to rub against stones for the purpose of ridding themselves of the roe, and besides the roe readily attaches itself to aquatic plants. As a general rule, however, it is best for the young fry if the pond is tolerably free from reeds and aquatic plants. It is useful, however, if such plants grow along the edges, especially *Festuca fluitans*, as its leaves, blossoms, and seeds form excellent food for the young fish. If there are in a pond no aquatic plants to which the fish can attach their spawn, birch or juniper branches should be thrown into the pond, which may prove of still further advantage, as the naturally impregnated spawn of the carp attached to these branches can be transported a considerable distance. Special attention should be given to the quiet and safety of the young fry. Spawning ponds should therefore not be near villages or pastures; on the other hand, it will not be advisable to have these ponds in very remote places, over which constant supervision cannot be exercised, as there are many two-handed lovers of young carp. All animals which are injurious to the spawn and the young fish should be kept away from the pond as much as possible; birds of prey

* Reimann, *Praktischer Abriss des Fischereiwesens*, 1804.

† Horak, *Teichwirthschaft*, 1869.

should be chased away or caught, and neither ducks nor geese should be allowed on the pond. The frogs should, if possible, all be removed, and in selecting a spawning pond, ponds containing many frogs should be avoided. If the ponds have but few or no aquatic plants, and are not surrounded by bushes or shaded by trees, few injurious animals will be found in or near them; and even if there should be some, they can easily be discovered and rendered harmless.

Spawning ponds need not contain a very large quantity of fish-food, for the quantity required by the young fry and the parent fish will not be great. On the contrary, ponds containing a scanty supply of food are to be preferred for spawning ponds, because a superabundance of food hinders the propagating process. Young fish which have been raised in ponds containing a great deal of food are, as a general rule, retarded in their growth when placed in poor raising ponds, while, on the other hand, fish which have lived on short rations will grow rapidly when placed in good raising ponds. If it is thought that a pond contains too much fish-food it will be well to place in it some more spawning carp, for a superabundance of young fry will never do any harm. Teichmann says on this subject: "The soil does not influence the production of fish as much as many people seem to believe. It is certain, however, that rich soil is rather injurious than otherwise, for in the spawning ponds the fish are to be produced, and not to be fattened." * Horak says: "The bottom of spawning ponds should not be composed of peat or sand, nor should it be rich enough to produce grain, because in the first case the young fish would be retarded in their growth by want of food, while in the second case they would be spoiled in their early age by too rich a food, and when transferred to the raising ponds would grow but slowly. The bottom of a spawning pond should, therefore, not be principally composed of humus, but be a medium, mild, clayey soil." †

My views on this subject coincide with those expressed in the last sentence quoted from Horak, and are that, as the nature of the carp requires good soil (among which I class medium clayey soil), the young fry should have the same kind of soil. But, apart from this, it cannot be said when a spawning pond is selected whether it will offer much or little food for the young fish, as the number of young ones produced by one spawner varies greatly. As a general rule, 1,000 to 1,500 may be counted to one spawner. Sometimes, however, there are less, and often twice as many. For a smaller number the pond may possibly offer sufficient food, while a larger number would suffer want. It is a common experience that young fish which, in poor or overstocked raising ponds, have been retarded in their growth, when placed during the following year in better ponds will make up for lost time. Thus I can state from my own experience that in an overstocked pond the young of

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* Teichmann, *Der erfahrene Fischmeister*, 1821.

† Horak, *Teichwirthschaft*, 1869.

two summers reached only a weight of 5 pounds for 60 fish, but that in the following year they reached the same weight as those which when placed in the pond had weighed 26 pounds per 60 fish. Such experiences, which are not reliable in all cases, should not induce any one to overstock the raising ponds during the first year, or to select poor ponds for raising ponds; much less should this be done with regard to spawning ponds. It may be laid down as a principle in fish-culture that as the fish develop during the raising years they should, if possible, be transferred from poorer to better ponds.

2. RAISING PONDS.

The young fry which have been produced in the spawning ponds are too small to be transferred at once to the stock ponds, where they would become the prey of larger fish before they could be raised to a marketable size. Before being transferred to the stock ponds the young fish should grow still more in size, and also grow stronger; and for this purpose they are, for a year or two, placed in other ponds which are called raising ponds. Good raising ponds are no less important than good spawning ponds; for the rapid production of marketable fish will greatly depend on this. Herak characterizes good raising ponds as follows: "They should be located in low lands, open towards the south, and sheltered towards the north; their water supply should, during thaw and rainy weather, come from the neighborhood of villages and from cultivated fields; their banks should not be sandy, steep, full of reeds, or shaded by trees; their soil should be favorable to the cultivation of grain, and it should be possible to supply them with the necessary water whenever it is deemed desirable. Under favorable circumstances a very large number of fish may be placed in them; if the weather is favorable the young fry may, during one summer, reach a weight of 60 to 90 pounds per 60 fish; although the result may be considered satisfactory, if in one summer they reach a weight of 30 to 40 pounds per 60 fish, and if the average weight, per 60 fish, of the fish from all the raising ponds reaches 18 to 20 pounds. Raising ponds lose much of their value, if there is no way of supplying them with water artificially, and if, for fear that they cannot be sufficiently filled in spring, they have to be filled immediately after the autumn fisheries; and likewise if, during dry seasons, their water becomes so low that their food-producing edges are laid bare. In ponds which are located below villages, and are used for watering cattle, the young fish are often seriously injured, and in many cases entirely destroyed."*

In my opinion, however, the watering of cattle does not necessarily injure the young fish, but will rather prove a benefit, as experience has shown that the growth of the young fish was favorable in raising ponds where cattle were watered, as they would generally drop their excrements. I even do not deem it dangerous to the fish, if the cattle go

* Horak, *Teichwirthschaft*, 1869.

far into the pond, as at their approach the fish immediately seek the ditches and the fish-pit, and when the cattle have left the pond, at once return to their feeding grounds to devour the excrements. I have, in my whole experience, never found the watering of cattle to be injurious to fish, but, on the contrary, favorable, and I have therefore gladly seen it, if cattle were watered in raising or stock ponds. Injury or danger can arise only if during very hot summers the water becomes too hot, and the fish consequently grow sick, which, of course, would be made worse by the watering of cattle. During very hot weather it should therefore not be permitted, at least in small ponds.

After the spawning ponds have been selected, there will hardly be any choice of raising ponds. In most cases it will be necessary to use the largest ponds as stock ponds, which of course would leave only the medium-sized ponds for raising ponds. In large establishments, however, in which there are two classes of raising ponds, there will be some chance to make a selection, in such a way as to select for those of the 1st class (which are to receive the young fry upon their arrival from the spawning-ponds), small, shallow ponds with warm water, avoiding especially ponds fed by spring water, leaving the remainder for raising ponds of the 2d class. When the selection is limited it should be the object of the pond culturist to improve his raising ponds as much as possible, which can generally be attained by sowing them systematically. The number of raising ponds should be large enough to supply all the fish needed for stocking the stock ponds. This also applies in cases where the stock ponds are not touched for two or three years, as on a properly regulated pond farm the same area of stock ponds should be stocked every year.

3. STOCK PONDS.

The stock pond is intended to develop the young fish which have been raised in the raising ponds, so as to make them marketable in the shortest possible time. Carp become marketable when they have reached a weight of $2\frac{1}{4}$ pounds. Most buyers, however, will prefer a weight of $2\frac{1}{2}$ pounds, although a good many carp are sold which weigh only 2 pounds. To answer their purpose stock ponds should possess all the requisites of a good carp pond, which are in most respects the same as those of a good raising pond. Above everything else they should have an ample supply of good fish-food. For stock ponds those large ponds should be selected which are not needed for raising ponds. As the fish must, as a general rule, remain in them two and sometimes three years, they should be of sufficient depth to afford comfortable and safe winter-quarters for the fish.

The experience of old-established pond farms has demonstrated the importance of having deep stock ponds; and in the construction of new ponds this should not be lost sight of. But even if the greatest care is exercised in the selection of the stock and other ponds, it will be impossible to reach absolute perfection and meet every demand,

as the area and the nature of the soil have to be taken as they are. To reach his object the pond culturist will have to improve his ponds gradually, following the hints given in previous chapters. An intelligent and energetic man will find ways and means to obtain the best possible results, no matter how he is situated.

4. WINTER PONDS.

In most cases a pond farm will only have few ponds in which the safe wintering of fish can be guaranteed; it will, moreover, hardly be possible to place all the fish from the raising ponds at once in the stock ponds in autumn; and finally, even if it was possible to leave the young fish in the raising ponds during winter, the supervision and management of these ponds, especially in an extensive pond farm, during the winter season would be exceedingly difficult, and it will therefore be absolutely necessary to have a few ponds in which a large number of fish can be safely wintered. Such ponds are called winter ponds. "To them," as Horak truthfully remarks, "is entrusted the entire hope of the fisheries; on their success depends the stocking of the stock ponds and of other ponds; in other words, the final success of the fisheries; and their failure will have the most serious consequences for the entire pond farm."* They should therefore be adapted to their purpose in every respect. Winter ponds should be on low ground, sheltered by woods, have high banks rising 1 to 1.5 meters above the surface of the water, be of considerable depth—not less than 2 to 2.5 meters—have the same depth at all times, and be capable of being supplied with fresh water at any time. They should be free from mud and aquatic plants, especially in their fish-pit, which should occupy about one-third of their entire area. If winter ponds can receive a constant supply of spring water, this will prove a great advantage, as it is warmer than brook and river water, and very rarely freezes in winter. A supply of water from higher ponds is to be preferred to brook and spring water, as its temperature will better agree with that of the winter ponds.

Considering that only in rare cases will all the above-mentioned qualities be combined in one and the same pond, winter ponds, which have been tried and found to answer their purpose, will rarely be used for other objects. Separate winter ponds are needed, not only for every kind of fish, such as carp, tench, pike, &c., but every age should also have its special winter pond. The number of winter ponds, and also their size—which need not be very great—will depend on the extent of the pond farm. If it is large, a comparatively greater number of ponds and larger ponds will be required.

In order not to render the necessary supervision and management of the fish during winter difficult on account of too great a number of winter ponds, large winter ponds are to be preferred to small ones, also for

* Horak, *Teichwirthschaft*, 1869.

the reason that these latter are more apt to freeze throughout during particularly severe weather than large ones. In small ponds, moreover, the snow-water, during a thaw, increases the quantity of water so suddenly that the fish are scared away from their resting-place, leave it, and suffer injury during succeeding frosts.

According to Horak, a large pond farm, intended to keep 60,000 to 90,000 fish, needs a pond area of 23 to 34 hectares, and a fish-pit, free from mud, of 8.6 to 11.4 hectares.* Jokisch characterizes a good and safe winter pond as follows: "It should be of sufficient depth so that, even during the most severe frost, it does not freeze to the bottom, but always retains an ample quantity of water. Winter ponds should not be exposed to floods occasioned by sudden thaws, for as soon as the fish notice an unusual motion in the water, they become excited and rise towards the surface, where they freeze to the ice and die. This is particularly dangerous in spring when a thaw is often succeeded by a severe frost. Winter ponds should be in a quiet locality, and during winter there should be no walking, sleighing, or skating on them, nor any knocking on the ice. Winter ponds ought, therefore, never be used for furnishing ice for ice-houses, because the cutting of the ice would seriously disturb the fish. The fish need a little air, especially when the snow is very deep, and to supply this a hole should be made in the ice, in which are stuck some bundles of reeds or straw, which reach down into the water and protrude above the ice. Whenever a pond has a good many reeds, air will naturally be supplied, and it will not be necessary to make a hole in the ice. Nothing, however, contributes so much to the success of a winter pond as springs, or a supply of spring water."† Horak also insists that the winter ponds should be near to the stock ponds, so as to make the transportation of fish easy, and that prior to being filled they should be sowed at least in part.* As regards the proximity of the stock ponds, it is of course desirable, but in selecting winter ponds this consideration should not be decisive.

5. THE RELATIVE SIZE OF THE DIFFERENT CLASSES OF PONDS.

In a well-regulated pond farm the size of the spawning and raising ponds should be proportionate to that of the stock ponds, *i. e.*, the former should always be ready to supply the necessary stock of fish of the required quality. To make this proportion correct is the first condition of successfully cultivating a given pond area, and of deriving from it the greatest possible income. If the proportion between the raising and stock ponds is not correct, this may give rise to difficulties, if there are in the raising ponds more young fish than can in two or three years be developed to marketable fish in the stock ponds; and, on the other hand, if the raising ponds cannot furnish the number of fish

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* Horak, *Teichwirthschaft*, 1869.

† Jokisch, *Handbuch der Fischerei*, 1804.

which in the given time can in the stock ponds be developed to marketable fish, it would be impossible to derive the greatest possible income from the pond farm. Still more serious difficulties would arise if the number and size of the winter ponds were not in due proportion to the number of fish which are to be wintered; and to avoid entire failure, a sufficient area of winter ponds would have to be obtained at any price, or if this is impossible, the raising ponds should be so arranged that fish can be wintered in them. This latter measure, however, would always have to be considered as a mere make-shift, and the lack of winter ponds would still make itself felt. A pond farm without winter ponds does not deserve to be called well regulated, and will never yield the profit which otherwise might justly have been expected from the given pond area.

An undue proportion of the spawning ponds to the other ponds will prove of serious consequences to pond culture, as it might be impossible to raise the required quantity of young fry; while a surplus of young fry will not occasion any difficulty, as in most cases they can be sold to advantage or prove useful by supplying food for the fish of prey in the stock ponds. It will, therefore, be better under all circumstances to produce an excess of young fry than run the risk of having too small a supply. In the latter case, it is true, the necessary supply of young fry may be obtained by buying some from other pond farms, but these bought fish may frequently not answer the purpose in every respect, and possibly they cannot be obtained in the neighborhood, and would have to be brought from a distance at a considerable expense; all of which would again result in causing the pond farm to yield much less income than might otherwise have been expected. If the spawning pond should be too small to hold the quantity of young fry to be expected from the spawners and milters placed in them, this difficulty may be obviated to some extent by using one or the other of the raising ponds occasionally as a spawning pond, but even at best this is a somewhat irregular proceeding, and its consequences will be more or less injurious to pond culture. The usefulness of an excess of young fry, however, also has its limits, and it would not contribute to the success of a pond farm, if one should be compelled to use a disproportionately large pond as a spawning pond; for, if it was to be stocked with spawners according to its area, a large portion of the young fry to be looked for could not be put to any use. In order to derive the greatest possible benefit from such a pond it will have to be used both as a spawning and as a raising pond, which again would be more or less injurious to the spawn and young fry. It will therefore be evident that wherever the relations as to size of the different kinds of ponds are not as they should be, a greater or less injury to the pond farm and a diminished income will be the consequence. This injury will grow from year to year, and finally become serious enough to ruin the entire pond farm.

Although it is impossible to lay down strictly binding rules as to the

relative size of the different ponds, as this will to a great extent depend on local circumstances and frequently on the experience of many years, it will be safe to say that in a pond farm whose ponds do not differ much from each other as to their supply of food, a total pond area of 100 hectares should—at least approximately—be divided among the different classes of ponds as follows:

	Hectares.
Spawning ponds	4
Raising ponds of the first class	12
Raising ponds of the second class	18
Stock ponds (of which in a two years' course 30 hectares should be stocked per annum)	60
Winter ponds	6
Total	100

The above figures not only give valuable hints, but they will serve as a safe guide in organizing a pond farm, where a two years' course in the stock ponds is contemplated. Later we shall, on the same principle, give the relative size of the ponds for a one year's course. In organizing a new pond farm it will, therefore, be well, in the beginning at least, to follow these figures, and only to deviate from them gradually as the circumstances require. Pond culturists will find no difficulty in following these figures by varying the number of fish in the different raising ponds according to their character, provided, of course, that the average number per pond is not placed too high. If, as is frequently the case in large pond farms, the character of the ponds varies considerably, the above figures may in course of time be somewhat different. Thus in the pond farm of Peitz, near Kottbus (Prussia), the total pond area of 4,600 acres is divided as follows:*

250 acres spawning ponds	= 5.42, in round figures	5 per cent.
500 acres raising ponds of the first class	=10.84, in round figures	11 per cent.
860 acres raising ponds of the second class	=18.65, in round figures	19 per cent.
3,000 acres stock ponds (one year's course)	=65.09, in round figures	65 per cent.
Total	100	100

This, however, does not include the winter ponds. According to the above proportion, and assuming the spawning pond to be equal to 1, the raising ponds of the first class are equal to 2, of the second class to 3.4, the stock ponds to 12, while on the basis of the figures given above the spawning ponds of the first class would be equal to 3, of the second class to 4.5, and the stock ponds (one year's course) to 7.5. In finding the most suitable system for a newly organized pond farm, or in correcting mistakes in the management of an old pond farm with a view to reorganizing it, it will under all circumstances be advisable to make the beginning on the basis of the figures first given above.

* Delius, *Teichwirthschaft*, p. 62.

6. GENERAL RULES AS TO THE STOCKING OF PONDS.

What kinds of fish are to be raised, and consequently with what kinds of fish the ponds are to be stocked, depends on the following:

1. On the character of the ponds, *i. e.*, the nature of the soil of each pond, on the quality of its water, and its supply of food; as the different nature of the various kinds of fish will cause a difference in the conditions necessary for success. Thus carp and tench want a muddy bottom and stagnant, warm water; while pike and perch want deep and running water, or water which at any rate is not stagnant; and trout need a stony bottom, with clear, cold, running water, with some places where the water is not in constant motion.

2. If ponds are to be stocked with several kinds of fish, the food necessary for each kind should be found in the pond, *i. e.*, fish of prey should, either in a natural or artificial way, be supplied with the necessary food-fish; care should also be taken to place only those kinds of fish in one and the same pond which are able to agree with each other; thus fish of prey with prickly fins will not agree with other fish; and if they are to be kept in carp ponds, their number should be reduced as much as possible.

3. It should be ascertained what kinds of fish are most sought after in the neighborhood, and will therefore have a ready and profitable sale.

All the above considerations should be carefully weighed, for to disregard them may cause serious losses.

Among all the different kinds of German fish the carp has for centuries occupied the first rank as a pond fish, and still holds its own. For reasons given in previous chapters, the carp certainly deserves this prominent place; and it is therefore the fish to which pond culture principally relates, the keeping of other fish being a mere secondary consideration. It is true that under special circumstances, particularly if the necessary food can easily be procured, trout-culture will pay better than carp-culture; and as matters stand at the present time in Germany, greater attention should probably be given to the raising and keeping of finer kinds of fish. The great progress made in artificial fish-culture, and the remarkable successes achieved on this new field of industry, will render this easier than it would have been in former times. It is nevertheless hardly probable that trout-culture will ever be carried on to such an extent as carp-culture.

In the following we shall occupy ourselves principally with the carp and those fish whose culture has for centuries gone hand in hand with that of the carp. The number of fish to be placed in a pond will depend: 1, on its size and the quantity of its water supply; 2, on the character of its water, and the quantity of food contained in it; 3, on the size and weight of the carp to be placed in it; and 4, on the length of time during which the ponds are to remain stocked with fish.

It will be impossible to lay down rules which will apply to every pond. Experience must gradually teach the proper rules in this respect, and a carefully arranged and punctually kept system of records will prove invaluable—in fact, be absolutely necessary. As a fundamental principle, however, we must state that a pond should never be overstocked. Horak says: "It is not the area of the pond, but the quality of the soil, the quality and quantity of the water, and the flat and easily warmed banks of the pond, which determine the success of the fish. It may, therefore, happen that small ponds can sustain a comparatively larger number of fish than large ponds, even if the quality of the soil is the same. In large ponds the pasture-grounds of the fish are comparatively smaller than in small ponds with shallow water and a grassy bottom, these latter furnishing more and better food and a more suitable place of sojourn for fish. The water of large ponds is seldom calm, and the waves are apt to disturb the fish. Large ponds, moreover, have generally sandy banks, while small ponds have a more evenly good soil, and are therefore more conducive to the well-being of the fish. The case frequently occurs that ponds having the same soil differ greatly from each other in other respects, and that ponds with poor soil are in reality better for the fish than those with good soil. The reason for these anomalies must be found in the difference of location. The heat of the sun can often replace the lack of good soil, and the cold water of a pond surrounded by woods can make even a pond with the best soil a poor one for purposes of fish-culture. To place fish of different kinds in one and the same pond is not to be recommended, because the larger fish will deprive the smaller ones of their food, although there are cases where a mixed stock of fish in one pond may be deemed advisable."*

As has already been stated, the number of fish to be placed in one pond will depend on their size and weight. On a well-regulated pond farm the fish are, before they are placed in the ponds, separated not only according to age, but also according to weight. My own experience has shown the following figures to be reliable:

Weight per 100 fish.

	Pounds.
One year's fish	1 to 1.7
One year's fish	1.7 to 2.5
Two years' fish, small	15 to 30
Two years' fish, medium	31 to 70
Two years' fish, large	71 to 100
Three years' fish	101 to 130
Four years' fish	131 to 180

All these subdivisions according to weight, however, will be needed only in large pond farms with a great many ponds, and even then only if the ponds differ greatly in their character; the difference, especially between the small and medium fish, will be very inconsiderable; the one year's fish will generally vary in weight between 1.6 and 2.5

* Horak, *Teichwirthschaft*, 1869.

pounds per 100 fish, the two years' fish between 35 and 70 per 100, the three years' fish between 100 and 130 per 100, and the four years' fish may sometimes reach the weight of 200 pounds and more per 100 fish, so as often to become marketable at that age. The above gradations of weight will suffice for all cases. Different names are employed for fish of different weight and age in the various parts of Germany, which is to be regretted, as it often leads to errors; and it would be advantageous if certain technical terms for fish of different ages were universally adopted.

In former times the fish were sorted according to their length, which, however, was not always a safe guide, for fish of the same length may differ greatly in breadth and volume. An experienced pond culturist should be able to judge of the weight of fish, and sort them accordingly, merely by looking at them. The stock pond is stocked, not only with carp, but also, to prevent the spawning of the carp or the production of young fish, with other fish, principally fish of prey. Although experience will be the principal guide in the matter of determining the number of fish to be placed in each pond, persons about to establish a pond farm, or those who take in hand an old pond farm, where no books have been kept—persons, in short, who lack experience—should have certain data on which they can base their plan, adapting it, of course, to the local circumstances. Such data will aid in determining what approximate number of fish should be placed in each pond, for it will not be sufficient to know and carry out the principle not to overstock a pond. A person should be able to determine, as nearly as possible, the proper number of fish which a pond, according to its location and character, can sustain, so as to avoid the understocking of ponds, which may also prove injurious.

The following should be considered as an attempt to aid in furnishing such data. On the pond farm at Wittingau, in Bohemia, which possesses the enormous pond area of 5,755 hectares, and whose circumstances will, therefore, not apply in all respects to medium-sized or small pond farms, the various classes of ponds are stocked in the following ratios:

A. *Spawning ponds:* 5 spawners and 3 milters per hectare.

B. *Raising ponds:*

Ponds.	Class of fish.	Weight per 100 fish.	Number of fish.			
			Very good.	Good.	Medium.	Poor.
Raising pond of the—		*Pounds.*				
First class	One year's fish	0.9 to 2.6	729	625	520	312
Second class	Two years' fish, small	18.6 to 37.3	520	437	312	156
Second class	Two years' fish, medium	37.4 to 59.0	437	312	208	104
Second class	Two years' fish, large	57.0 to 112.0	312	208	156	78
Stock pond—						
First year	Three years' fish	113.0 to 149.0	208	156	104	52
Second year	Four years' fish	150.0 to 202.0	156	104	78	52

The number of fish per pond, therefore, varies: In raising ponds of the first class, from 312 to 729 fish per hectare; second class, from 78 to 520; in stock ponds, from 52 to 208.

For the better understanding of these figures, we would state that under ordinary circumstances the one year's fish are placed in the raising ponds of the first, and the two years' fish in those of the second class. The carp which, in the raising ponds of the second class, have grown to be three years' fish are placed in the stock ponds for two years, during which time they will reach a weight varying, according to the character of the pond, from 2.5 to 5 pounds. If it should happen that the small or medium two years' fish in the raising ponds of the second class do not reach a sufficient size for placing them in the stock pond, they should be allowed to remain in these ponds for another year, or the course of the stock ponds should be extended to three years. It should be the object of the pond culturist to make the fish in the stock ponds marketable in one year, which, in good or medium ponds, is entirely within the reach of possibility.

C. *Stock-ponds.*—According to Horak,* stock ponds should have from 47 to 118 fish per hectare. It should be borne in mind, however, that this ratio refers to ponds having an area of 100 to 400 hectares, and that smaller ponds will often sustain two and three times that number of fish. Delius † does not state the number of fish to be placed in the stock ponds; for spawning ponds he counts 4 milters and 8 spawners—at most, twice that number—per hectare; and for raising ponds of the first class, 960 to 1,440, and for those of the second class, 480 to 720 fish.

These figures are very much like those of the Peitz estate, near Kottbus, the largest pond farm in Prussia, concerning which Delius has published the following statistics:

Ponds.	Area.	Stock.	Result.*	Loss.
	Hectares.			*Per cent.*
40 spawning ponds	6,250	450	210,000	....
21 raising ponds for the second year	12,500	210,000	150,000	30
5 raising ponds for the third year	21,500	150,000	108,000	28
6 stock ponds (one year)	75,000	108,000	93,000	12
Total	115,250			

* Total result=200,000 pounds.

The losses on this farm are comparatively heavy, probably owing to the large number of herons and pike. The ratio of stocking these ponds per hectare is, therefore, as follows: Raising ponds of the first class, 1,680 fish; second class, 1,008; stock ponds, 264.

The above figures, however, can hardly be considered as standard, for they really seem enormous, as regards the raising ponds, and it is probable that they have been adopted for the Peitz farm with a view

* Horak, *Teichwirthschaft*, 1869.

† Delius, *Teichwirthschaft.*

to reach a somewhat favorable result, in spite of the very anomalous local conditions. If there were no large losses, it would be sufficient to raise in the raising ponds only that number of fish which remain for the market. In that case, the ratio of stocking would be about as follows: For the raising ponds of the first class, 768 fish per hectare; second class, 446; for the stock ponds, 130.

Even these figures must be considered rather high, especially as regards the raising ponds, and show the excellent quality of the Peitz ponds, in which young fry are, in a period of four years, developed to marketable fish.

Von dem Borne* who does not make the distinction of raising ponds of the first and second class, gives the following figures as the proper ratio per hectare: For spawning ponds, 9.6 spawners, 6.4 milters, 3.2 drivers; and for raising ponds, good, 600 to 800 fish; medium, 400 to 600; poor, 100 to 400.

G. Kraft † gives the following figures: Spawning ponds per hectare, 6 to 12 spawners, 4 to 8 milters, and to every 3 milters 1 driver; raising ponds of the first class, 300 to 600 fish, average 450; raising ponds of the second class, 180 to 420 fish, average 300; stock ponds, 120 to 180 fish, average 150.

As they are, these figures cannot serve as a general guide if we take the relative size of the various kinds of ponds as given above, because they do not meet the first demand of a well-regulated pond farm, viz., that the number of fish needed for the stock ponds shall be raised in the raising ponds. If we calculate the ratio of stocking on the basis of the relative size of the different classes of ponds, as given above, which on the whole seems to be correct, we obtain the following result:

Ponds.	Area.	Number of fish.		
		Minimum.	Average.	Maximum.
	Hectares.			
Raising ponds of the first class	12	3, 600	5, 400	7, 200
Raising ponds of the second class	18	3, 240	5, 400	7, 560
Stock ponds (one year's course)	60	7, 200	9, 000	10, 800
Stock ponds (two years' course)	30	3, 600	4, 500	5, 400
Stock ponds (three years' course)	30	3, 600	4, 500	5, 400

It will be seen at a glance that in a one year's course the raising ponds cannot produce the necessary number of fish for the stock ponds, and that if the two years' course is adopted, more fish are produced in the raising

* Von dem Borne, *Fischzucht.*
†G. Kraft, *Landwirthschaft.*

ponds than they can accommodate to any advantage. In order to correct this, the ratio of fish per hectare will have to be as follows:

Ponds.	Number of fish.		
	Minimum.	Average.	Maximum.
Raising ponds of the first class	300	450	600
Raising ponds of the second class	200	300	400
Stock ponds (one years' course)	120	180	240
Stock ponds (two years' course)	60	90	120

Which would give for a total pond area of 100 hectares, reserving 6 hectares for winter ponds, the following ratio:

Hectares.	Ponds.	Number of fish.		
		Minimum.	Average.	Maximum.
12	Raising ponds of the first class	3,600	5,400	7,200
18	Raising ponds of the second class	3,600	5,400	7,200
30	Stock ponds (two year's course)	3,600	5,400	7,200
30	......do	3,600	5,400	7,200
60	Stock ponds (one year's course)	3,600	5,400	7,200

The above figures must be considered the best and most rational. To these should be added the so-called "excess," which, however, need not be calculated here, as it will generally be destroyed during summer, and will therefore not burden the ponds. In order to neutralize the unavoidable losses by transportation, wintering, fish of prey, birds of prey, &c., as well as the cases of death which will necessarily occur even on the best-regulated farms, a larger number of fish than the ponds are entitled to are placed in them, and this excess over the normal figures is generally determined by the known or estimated loss in former years, or on other pond farms.

According to Krafft* the average losses are: In spawning ponds, 12 to 14 per cent; in raising ponds of the first class, 10 per cent; of the second class, 7 per cent; in stock ponds, 2 to 8 per cent.

That these losses will in many cases be much greater may be seen from the statistics of the Peitz farm given above. According to Horak,† the average losses are: Of small two years' fish, 13 to 14 per cent; medium two years' fish, 13 to 14 per cent; large two years' fish, 10 per cent; three years' fish, 6 to 7 per cent; four years' fish, 3 to 4 per cent.

With a view to expedite matters, and also to avoid any unnecessary handling of the fish, the young fry are not counted, but measured, for which purpose a measure holding 60 to 100 is used. Different measures should be used for the different kinds of young fish, and on large pond farms it will generally be found necessary to use three different meas-

* Dr. Krafft, *Landwirthschaft.*

† Horak, *Teichwirthschaft,* 1869.

ures. One may, of course, employ any measure he chooses, after its capacity has been ascertained. In this latter case the measure—generally a small net or a perforated tin ladle—ought to hold a little more than 60 young fish, while in the former case a larger measure should be employed, allowing for the excess referred to above.

If these rules are observed the fisheries will, under favorable circumstances, yield a moderate surplus, because the excess is not entered on the books; but it may also happen during an unfavorable year that, in spite of the excess, there are actual losses, generally owing to the circumstance that the excess had not been calculated according to the greatest loss during a period embracing several years. As such losses may seriously disturb the systematic management of the farm, it will be well to make the excess rather high than otherwise. A moderate surplus—say about one-half of the excess—will be considered very desirable by every pond culturist, while a large surplus, which can be gained only by interfering with the normal growth of the fish, will not be considered profitable.

As regards the excess, care should be taken to make it, for the one year's fish, equal to the estimated total loss during the four or five years' period of raising, so that finally the stock pond may yield its normal product during the fisheries. If there is danger that by a great excess (necessitated possibly by local circumstances) the growth of the fish is retarded, nothing remains but to be contented with a comparatively small normal product of the stock ponds.

Taking as a basis the losses as given by Krafft, the excess should be: For two years' fish 25 per cent, in the raising ponds of the first class; for three years' fish 15 per cent, in the raising ponds of the second class; for four years' fish 8 per cent, in the stock ponds.

If we compare the ratio of fish per pond, given last, with the data furnished by Horak and Delius, and with the experience of the Peitz farm, we find that it may justly be considered as standard in most cases.

We must expressly state, however, that this does not imply that the relative size of the ponds, as given by us, should in practice be exact, even down to an are or square meter; this would be impossible, and will only be approximately attained in a pond farm containing a great many different ponds. Nor do we mean to say that the stocking of the ponds should only be carried out on the basis of three classes of ponds—good, medium, and poor. It will, on the contrary, vary as much as the endlessly varying character of the ponds; but, under all circumstances, it will be necessary that the proportion between the classification of the ponds and the quantities of fish placed in them should be made to harmonize, for otherwise there is danger that the raising ponds will not furnish the necessary number of fish for the stock ponds. To obtain this necessary number, at least approximately, it will be advisable, in large pond farms, to form the ponds into groups, according to their character, give each group a separate stock pond, and manage each group

by itself. Even in small or medium-sized pond farms which possess a great number of ponds this method will be found profitable. As the increase in the weight of the fish per annum in the stock pond will indicate the number of fish with which it is to be stocked, if this increase is to reach a certain height within a given period of time, and as the relative proportion of the ponds should be such as to enable them to produce the number of fish required for the stock ponds, we should be able, on the basis of the relative size of the ponds as given by us, to fix the proper number of fish for the raising ponds of the first and second classes. To do this it will be necessary only to regulate this number on the following principle: Stock pond = 1; raising pond of the first class = 2.5; raising pond of the second class = 1.66 (or 1.67) per hectare.

The relative size of the ponds, as given by us, will, however, only be advantageous if it is intended to work the stock ponds in a two years' course. The number of fish which we gave for a one year's course in the stock ponds is rather low; and if we wish to apply this number to a two years' course—which may be done in good ponds—and thus make the fish marketable in the fourth year, the proportion of the different classes of ponds will have to be changed, and would in a total pond area of 100 hectares be as follows:

	Hectares.
Spawning ponds	6
Raising ponds of the first class	17
Raising ponds of the second class	25.1
Stock ponds	42.5
Winter ponds	9
Total	100

Supposing the stock pond could stand only 100 fish per hectare, we get the following number of fish per hectare: Raising ponds of the first class, 100×2.5=250 fish; of the second class, 100×1.66=166 or 167 fish; and the entire number of fish would be distributed as follows: 17 hectares raising ponds of the first class at 250=4,250 fish; 25.5 hectares raising ponds of the second class at 166 to 167=4,233 to 4,250 fish; 42.5 hectares stock ponds at 100=4,250 fish. The difference between the raising pond of the second class and the stock pond (17 fish) is caused by the repeating decimal fraction (1.6+), and is very insignificant, and we place in the raising pond of the second class 4,250 fish, because if we were to stock the raising pond of the first class in exact proportion to the stock pond, we would at any rate have these 17 fish on hand. If we had regulated the stocking of the raising pond of the first class according to that of the stock pond, that of the raising pond of the second class will regulate itself naturally, according to the stocking of that of the first class, and small differences need not at all be taken into consideration. All that can be done in laying out the plan for managing a pond farm, will be to get approximate figures, so as to have some sort of a basis of operations and not to work entirely in the dark until expe-

rience will show after years which are the figures that are most likely to insure success.

As regards the spawning ponds, there is—if the relative size of these ponds should not be quite up to the standard—less danger that they could not produce the number of fish necessary for the stock ponds, because too small an area can, in case of necessity, support two and three times the standard number of spawners.

The proportion of the area of the winter ponds to the entire pond area is not so important as the proper proportion between the raising ponds and the stock ponds, for if necessary raising ponds can easily be transformed into winter ponds, and if these ponds are properly arranged, double the number of fish per hectare can be wintered in them. The case may frequently occur that the given pond area is such as to make it impossible to maintain the standard relation of size of the different classes of ponds. In whatever way we may make our calculation, we shall in that case always arrive at the result that it will be impossible to stock sufficiently one or the other of our ponds, and that consequently we must suffer more or less loss, which but rarely will be prevented by accidental circumstances.

The greatest possible profit which can be derived from an entire pond area will be diminished in proportion as one is compelled to make changes in the standard relative size of the different classes of ponds.

The correctness of this assertion will at once become apparent if we, for instance, compare the management of a pond farm having an entire pond area of 100 hectares divided among 4 ponds of 25, or 5 ponds of 20 hectares, with that required by a pond farm likewise embracing a pond area of 100 hectares but divided among 5 ponds of 4, 12, 15, 60, and 9 hectares. After the various ponds have been assigned, some for spawning, others for raising, and others for stock ponds, it must be ascertained whether the individual ponds of one and the same class differ very considerably from each other in regard to their nature, whether they resemble each other or have the same character in all respects. In the last-mentioned case it will be best to place an equal number of fish per hectare in each of these ponds. If, however, one has a number of ponds whose soil and other qualities differ very considerably from each other they should be subdivided into different categories according to their quality, and the same number of fish per hectare should be placed in all the ponds of one and the same category.

The result of the first year during which this method of stocking has been employed—making the number of fish rather too low than too high—will enable the pond culturist to form a tolerably correct idea of the quality of each individual pond, if compared with the other ponds and the entire pond area. In this way the overstocking of the entire pond area will be avoided. The possible overstocking of one or the other of the ponds will only aid in arriving at some definite opinion as regards their relative productivity; and if the proper ratio of stocking

has not been ascertained in the beginning, a few years of experience will be sufficient to find the proper standard. If, however, the plan of managing a pond farm does not appear to be absolutely erroneous during the first year, one should be slow in introducing changes; and if they seem unavoidable, the outlines of the system once adopted should be preserved as much as possible, so as to prevent injury to the entire farm from a failure of such changes. If among the ponds there are some which are not adapted to carp-culture, it should be considered whether they could not be more profitably employed for raising or keeping other fish, as trout, eels, &c. As the largest ponds should be used for stock ponds, and as consequently one will have to deal with a given area which possibly is still too large, if compared with the area remaining for spawning and raising ponds, it will be necessary either to overstock these ponds and supply the lack of area, and consequently of natural food, by artificial feeding, or to buy fish for stocking the stock pond to its full capacity, or prolong its course for another year; in which case, however, no fish of prey should be placed in it at least during the first year, as the carp would have to enter it when only two years old.

In order to derive the full profit from a pond, *i. e.*, to stock it in such a manner as to cause it to yield the best possible result, one should know how many pounds of fish can be raised in it per annum, and from this it can be calculated how many fish will have to be placed in a pond to raise within a given time a certain weight of fish. This should be known especially as regards the stock pond or ponds, for, being the largest ponds, they should yield the largest income, and in proportion as this object can be reached, one should regulate the stocking of the spawning ponds and raising ponds. From autumn till spring—generally from October till April—there is a pause in the growth of cultivated fish; and not till vegetation begins to revive do they again commence to grow. Frequently half of the month of May is included in this period of rest, as the weather is often cool enough to cause the fish to seek the deep water. In September the weather again grows cooler, the number of insects, worms, and plants on which fish live begins to diminish, and it is therefore a rare case if carp, or any other cultivated fish, increase in weight during the second half of September. Fish of prey, as a general rule, grow more rapidly than tame (cultivated) fish, provided there is a sufficient quantity of food; but they rest only for a short time during winter, and pursue their warfare against other fish during the remaining portion of that season. Horak remarks relative to the growth of carp: "During average years the increase in weight will generally be as follows: in May, 10 per cent; in June, 30 per cent; in July, 35 per cent; in August, 20 per cent; in September, 5 per cent. Total, 100 per cent.

"If the weather throughout the entire month of May is warm and calm the increase in weight during that month may be twice as great as that

given above. During summer the carp resort to the edges of the ponds about 9 o'clock in the morning, and remain there till midnight, when they return to the deep water, where they appear to rest, to commence their daily routine again about 9 o'clock the next morning. The age of fish exercises a great influence on their increase in weight. The younger a fish the more rapidly will it grow, while the growth of an old fish is slow. The pond culturist, therefore, should aim at having only young fry and young fish, which form the backbone of a good pond farm."*

The growth of the carp will be specially favored by not placing too many fish in a pond in proportion to its quantity of food and water. Besides suitable food a fish also needs for its proper development sufficient space, so as to allow freedom of movement. The goldfish, which are closely related to the carp, furnish a proof of this. In ponds they will reach a length of 30 to 45 centimeters, while in glass globes they only reach 6 to 12 centimeters, during an age of two years. I have even known goldfish to reach the age of eight years without growing any longer than about 12 centimeters. In good ponds young carp can reach a weight of 10 grams † apiece during the year of their birth, 256 grams during the second, 650 during the third, and 2½ pounds to 5 pounds during the fourth year; and in exceptionally good ponds the ratio of increase is even greater.

7. STOCKING OF THE SPAWNING PONDS AND PRODUCTION OF YOUNG FRY.

After the spawning ponds have been selected and filled, the spawning carp are placed in them. As there are different kinds of carp, such as the common carp, the mirror carp, and the leather carp, it will be necessary to state which of these different kinds should be recommended. The only suitable fish for pond culture is the common carp. It is true that the mirror carp has its admirers, and sometimes sells at a higher price than the common carp, but in spite of this, it cannot be recommended for cultivation in ponds. It is not protected by scales, and is therefore more liable to be injured; and even in good ponds it never reaches the size and weight of the common carp. As a general rule the common carp is the variety most sought after. What has been said of the mirror carp also applies to the leather carp. If, however, there should be many admirers of the mirror carp in some locality, so that it would fetch a higher price than the common carp, it may be recommended to raise it in special spawning, raising, and stock ponds.

It is an old adage, "Like parents, like children;" and it will, therefore, behoove the pond culturist to be exceedingly careful in selecting his spawning carp. As a general rule they should be fully matured, the milter should be long and narrow and the spawner round and plump.

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* Horak, *Teichwirthschaft*, 1869.

†There are about 453.6 grams in 1 pound (avoirdupois); hence in 2½ pounds there are 1,134 grams.

The spawning carp are selected in autumn during the fisheries in the stock ponds, and are, during winter, kept in special tanks, where they receive little or no food, for they should not be fat, but only fully matured; and they are, therefore, generally taken from poor ponds. It is not very difficult to distinguish the male from the female carp, still it may require a little practice.

Horak says: "Fishermen who are not able to determine the sex of a fish at once are in the habit of squeezing the genital parts until they yield either milt or roe. This method is very injurious to the production of young fish. An experienced pond culturist will, at the first glance, distinguish a male from a female carp, even when they are only one year old. The milter, or male fish, has a depression or concave place in its genital parts, while the spawner, or female fish, has a protuberance or convex place."*

The aperture of the navel also seems to be somewhat larger and redder in the female than in the male.

Reimann characterizes good spawning carp as follows: "They should have a long-stretched shape, have a bright, shining, yellow color, and be entirely free from bluish or reddish spots; nor should they have lost any of their scales. The best age is between five and seven years, and the proper weight four to five pounds."† Horak says: "Spawning carp should be raised in medium ponds, weight not less than four and not more than six pounds, and not be younger than four and not older than six years. Their shape should be long-stretched, and they should be well grown and built, the head small and the body long. The spawner should be well rounded, but not too plump; the milter should have a bright, shining belly, hard to the touch. All the scales should be perfect. Every year the scales grow thicker, a new leaflet or layer being added, which may be easily distinguished through a magnifying glass. Fish with thick scales are old."*

In making the selection, care should also be taken that all the spawning carp are of the same age, so that young should not pair with old fish, as a great deal will depend on this. If fish of unequal age are paired one may look for delay in the production of the young fry, or for young fish of very unequal growth. On a systematic pond farm where fish of every age are raised in separate ponds and are developed into marketable fish in certain regular and well-defined periods, and where books are kept for every pond, there will be no difficulty in making the proper selection of spawning carp. As, nevertheless, the growth of carp will be unequal, especially on large pond farms, those fish which have been retarded in their growth will either have to stay another year in separate ponds or they will have to be placed in stock ponds and stay there two, and perhaps three, years. No experienced pond culturist

* Horak, *Teichwirthschaft*, 1869.

† Reimann, *Praktischer Abriss des Fischereiwesens*, 1804.

will place in one and the same pond fish greatly differing in age or weight. A difference of one year in the age of the spawning carp may possibly not do much harm; but if greater, this difference will surely make itself felt by a diminished quantity of young fry. It should, therefore, be considered an inviolable rule to place in one and the same spawning pond only milters and spawners of the same age, and if possible of the same weight.

Spawning carp should not be used for propagating purposes more than once, but should be sold, after they have fulfilled their mission; for old spawning carp become indolent, remain too long in deep water, and spawn too late, thus preventing the young fry from reaching their proper development during the short remaining part of summer.

There is great difference of opinion as to what number of spawning-parties (each composed of three fish) should be placed in a pond, or rather what relation that number should hold to its area. The same difference of opinion prevails as to the relative number of milters and spawners. The number of spawning-parties does not appear of great importance as long as a certain limit has not been exceeded; the relative number of milters and spawners, however, may to a great extent influence the result of spawning. Delius counts one milter and two spawners to every 25 ares.* These three carp compose what is technically termed a "spawning-party." Horak says: "It is important to fix the relative number of male and female fish. Pond culturists differ in their opinion on this point, and the proportion of female and male fish varies considerably in the different countries. Many years ago it was the practice in Southern Bohemia to count one milter to every two spawners; and it is alleged that among the young fry the female predominated, so much so that buyers began to grumble at the excessive number of female fish. Since that time it has been the custom to count two milters to three spawners, to which was generally added one 'driver,' or 'enticer'—always one 'enticer' to three milters. These so-called 'drivers' are three-year old fish (weighing about 70 to 80 pounds per hundred), which are not used for spawning, but simply to drive or entice the other fish to that process, and which should always be milters."†

As regards the number of milters for a given pond area there is likewise great difference of opinion and practice. Von dem Borne counts, per hectare, 9.6 spawners, 6.4 milters, 3.2 "drivers." Dr. Krafft counts, per hectare, 6.12 spawners, 4.8 milters, and to every three milters one "driver"; Horak, 5.21 spawners, 3.47 milters; Von Reider, per 34.07 ares, two spawning-parties, each composed of one milter and two spawners, or per hectare, about 6 milters and 12 spawners.‡

As long as there is so much difference of opinion, it will be best to take the average of these figures, and therefore place in poor spawning

* Delius, *Teichwirthschaft*, p. 58.

† Von Reider, *Das Ganze der Fischerei*, 1825

‡ Horak, *Teichwirthschaft*, 1860.

ponds 6 spawners, 4 milters, 1 "driver" per hectare; in medium spawning ponds, 9 spawners, 6 milters, 2 "drivers" per hectare; in good spawning ponds, 12 spawners, 8 milters, 3 "drivers" per hectare.

To avoid any trouble from lack of young fry, it will be well to have several spawning ponds, so that if the spawning should prove a failure in one pond the other ponds can make up for the loss. In cold, windy summers fish do not spawn much, and many female fish do not spawn at all; and at best the spawn, after having been deposited, is only hatched in part; or fish of prey, especially pike, enter the pond, which even happens sometimes in sky ponds; or other enemies of the spawn and the young fry are more numerous in one year, or in one particular pond, thus making the quantity of spawn uncertain.

Delius says: "One milter and 2 spawners—at most double that number—are generally considered sufficient per 25 ares, from which 300 to 1,500 young fish may be looked for, according to the way in which the fish spawn and the degree to which the pond is protected against enemies. This method I must consider as wrong, for it is most decidedly one of the causes of a small production of spawn. It is feared that by placing too many spawning fish in one pond the production of young fish would be so great as to cause lack of food, and keep the fish small and weak. This fear is well founded; but this should never prevent any one from placing ten times as many spawning fish in one pond, as the young fish can easily and at a trifling expense be fed artificially. If it should be found that there are, nevertheless, too many young fish, they may easily be caught near the entrance grate or in their feeding-place and placed in other ponds, or used as food for pike. This, of course, implies that a careful examination as to the quantity of young fry should be made after the spawning season. For this purpose some bran should be scattered along the edge of the pond, and by visiting the place about noon one will soon get an idea as to the quantity of young fry in the pond. About that time the little fish leave the deep water and seek the shallow places near the edges of the pond, for the purpose of playing and seeking food. Bran, meat chopped very fine, or boiled potatoes crushed into small pieces, may serve as food. If the number of young fish is very great they endeavor to escape from their pond, and generally go towards the place where the water flows into it. If there is a slight depression in the bottom in front of the entrance grate the young fish will there gather in large numbers about midday and jump up against the grate. If it is possible to fence off this depression by some boards and dip the water from it, a great many little fish can easily be caught. I have in this way dipped 24,000 young fish from a pond having an area of 16 acres, in a few days."*

In another place Delius says: "The first condition of successful carp fisheries is the certain production of young fish, either by propagation or by buying them, if possible, when still young fry, so as to make sure

* Delius, *Teichwirthschaft*, p. 59.

of a good stock of young fish. The result of propagation can never be calculated with absolute certainty; and it is, therefore, advisable to stock the pond with a large number of spawning fish. Formerly it was considered a misfortune if young fry occurred in the stock ponds, for they will diminish the quantity of food in the ponds. But times have changed, new objects have arisen, and the methods have consequently been compelled to undergo a change. It will certainly do no harm to place a few spawning fish in every pond, if one only takes care to watch and ascertain the quantity of young fry, so as to be sure to make the supply of food ample. Even if occasionally there should be a surplus of young fry, this will always find buyers; and by supplying it with the necessary food it may be retained and sold when the young fish have reached the age of three years."*

Although I agree with Delius in his first remarks, I must consider it something of a venture to place spawning fish in all the ponds, by which he can mean only the raising and spawning ponds, as in the stock ponds the young fry would become the prey of the pike, and I would not advise this, except in case of absolute necessity. I cannot share the fear that the quantity of food would be diminished by the young fry, but I rather fear that the young fish will get too little food, as experience teaches that the large fish drive the little ones away from the feeding-places and rob them of their food. Moreover the young fry would not find that rest which is so necessary for their proper development, if there are many other fish in the same pond. Although rarely, it nevertheless occurs sometimes that three-year or four-year old fish spawn in the raising ponds. In that case the young of these immature fish would mingle with those of the spawning fish. No young fry produced outside of the spawning ponds, even if ever so fine, should be used for raising. In order, therefore, to make sure of a sufficient quantity of young fry, it should be distributed over a number of small spawning ponds, which should be stocked with a comparatively large number of spawning fish. Whenever young fry occur in stock ponds, this will in all cases have to be considered as a misfortune, as the food necessary for the other fish will be diminished, and because the spawning of the fish decreases their weight. To remedy these evils fish of prey should be placed in the stock ponds so as to prevent the tame fish from spawning, and at any rate to decrease the quantity of young fry. Although in our times spawn and young fish will find a readier sale than formerly, it can hardly be deemed advisable to deviate from the above principles. The favorable results which have accompanied the artificial hatching of various kinds of salmonoids have led people to think that the same method might be employed with the carp; but the attempts in that direction have proved successful only in rare cases, the main difficulty being the adhesive quality of the eggs. As it is not our object to treat of artificial hatching, it will not be necessary to enter further into this matter. It will

* Delius, *Teichwirthschaft*, p. 93.

be best in all respects to avoid everything artificial in carp-culture. All that can be done to aid in producing a favorable result of the spawning process, is to make a suitable selection of the spawning ponds and the spawning fish, to place the fish in the ponds at the proper time and to put some stones and branches in the water, so the fish may rub against these and deposit their spawn. In this way, Von Reider says, spawn may easily be transferred from one pond to the other: "Take the root of a willow growing on the bank of the pond, which has a great many fibers and small roots, tie it to a stone and throw it into the water where the fish gather. The fish will soon approach this root, especially if there are no aquatic plants near by, and deposit their spawn on the root. If this root has been thrown into the water during calm, warm weather, it can be taken out after a few days, and thrown into the pond which is to be stocked with spawn, in a place where the water will cover it to the depth of 8 to 12 centimeters."*

The above method may be applicable in rivers and brooks, but cannot be recommended in pond culture, for all that would be gained would be a saving in the number of spawning carp to be placed in the ponds, which would be a doubtful advantage. This method may, however, possibly be used with profit in carp-culture in the following manner: Although, like many other pond culturists, I am, on general principles, opposed to everything artificial in carp-culture, the artificial protection of the eggs seems to deserve some attention and be worth a trial. Molin says on this subject: "If eggs adhering to different objects, *e. g.*, carp eggs or tench eggs, are to be hatched in summer and in stagnant water, take a shallow wooden tub, place in it the aquatic plants to which the eggs adhere, fill it with water, and place it in the sun. If the temperature during the day rises above 20 or 25 degrees, cover the tub with a piece of linen or with some green branches; and if during the night the temperature falls below 16 degrees cover it with a straw mat or a wooden lid."†

The time when the spawning carp are to be placed in the spawning ponds cannot be accurately fixed as to the month and day. The best time is in the beginning of spring when the weather, and consequently the water, begins to get warmer. This time may be in March, April, or May. It should be laid down as a rule not to place the spawning fish in the spawning ponds before warm spring weather sets in. To do it too early in the season will always be injurious, and nothing can possibly be gained thereby. Even if the spawning carp should spawn sooner, the spawn will remain unhatched until the sun is strong enough to do this; and the longer it remains in that condition the more will it decrease, owing to its many enemies. The quicker the spawn is hatched the more numerous will be the young fry. Teichmann says: "Spawning carp should not be placed in the ponds too early in the season, when

* Von Reider, *Das Ganze der Fischerei*, 1825.
† Molin, *Rationelle Zucht der Süsswasserfische*.

the water is still cold. Many people hold a different opinion, but I think they are mistaken, and I shall state the reasons why I think so: The water of the winter ponds is warmer than that of the other ponds; (1) because during the very coldest months many fish have been gathered there; (2) because most winter ponds have so-called warm springs. It is a remarkable fact that even during the most severe cold it will not be safe to venture on the ice of such ponds; (3) because, owing to their location, they are not so much exposed to the cold winds as the raising ponds, which are often entirely frozen, while the winter ponds are still free from ice.

"It must also be remembered that during winter the fish keep close together, and probably communicate warmth to each other. If one or the other of the above causes exercises an influence on the spawning of the carp, which cannot be denied, it must be considered a great mistake to transfer the spawning carp too early in the season from the winter ponds to the spawning ponds. Even allowing that spawning is not entirely prevented thereby, it may be retarded. If the young fry are, as the saying is, as small as plum-stones—an experience which every pond culturist will have to make at some time or other—the cause of this will probably have to be sought in the circumstance that the spawning fish were placed in the spawning ponds too early in the season."*

It is an undoubted fact that, owing to the causes given above, the water of the winter ponds is warmer than that of the other ponds; but I am inclined to doubt that the fish communicate warmth to each other, like warm-blooded animals, because they always have the temperature of the element in which they live, and can therefore only communicate to each other the temperature of the water which surrounds them. When the spawning carp are taken from the winter ponds in order to be placed in the spawning ponds, they should be once more carefully examined, and taken to the ponds and placed in them by thoroughly reliable persons.

In transporting these fish great care should be exercised. The kegs in which they are conveyed should be entirely filled with water, so that during the journey the fish cannot be knocked about and hurt. The fish should be placed in the kegs with the greatest possible care, one by one, head foremost; and a keg having a capacity of five hectoliters should not hold more than 20 or 25 fish. The fish should be taken from the kegs with the same care, and one by one. The person who attends to this should stay near the pond, until he has convinced himself that all the fish have left the edges; as it has often happened that, as soon as he turns his back to the pond, thieves come and easily catch the spawning carp which have remained near the edges. Even with the most favorable weather the spawning carp will not spawn immediately after they have been placed in the pond, but have first to become

*Teichmann, *Fischerei*, 1831.

acquainted with each other. This is another reason why (especially if but few spawning-parties are placed in a pond) small ponds should be selected for spawning ponds. As soon as the fish have became acquainted with each other, and the water has grown warm, the spawning carp may be seen to seek the shallow spawning places near the edges of the ponds. Then the spawning process takes place. Horak describes this process as follows: "The female fish, or spawners, accompanied by the male fish, or milters, move rapidly along the edges of the pond, or near the calm surface of the water. The actual process of spawning generally takes place during the early part of the forenoon. I have taken careful observations of this process, and have invariably noticed that several milters always accompanied one female fish, and deposit their spawn, for not all females spawn at the same time. Sometimes this accompanying degenerates into a regular chase which lasts until the act of propagation has been consummated. At the beginning of the spawning season the fish therefore gather in large shoals and move so close together as actually to touch each other. During warm, calm weather the spawning process is carried on at so lively a rate, that the water is squirted 50 to 85 centimeters above the surface."*

The best time for carp to spawn is the end of May or the beginning of June. At that season the pond culturist should pay frequent visits to his spawning ponds and watch the spawning and everything which may be helpful or hurtful to this process. This becomes all the more necessary, as during the spawning season the fish are so little shy that they can easily be caught by the hand near the edges of the ponds. If the weather is favorable the spawning season does not last long. Fourteen days to three weeks after having been deposited the eggs are hatched. The small being contained within the shell bursts it, and soon develops into a lively little fish. The deeper the eggs are in the water, and the lower its temperature, as well as that of the air, the later will they be hatched. Spawning ponds should always be kept under careful supervision, and everything calculated to disturb the propagation of the fish should be promptly removed. No cattle should ever be allowed to graze on the banks of the spawning ponds. Birds of prey and other dangerous animals should either be driven away or caught or killed. Great care should be exercised to prevent any fish of prey from entering the spawning ponds, and if, in spite of every care, they nevertheless get in, they should be caught as quickly as possible. Tench should not be suffered in the spawning ponds, because they will also spawn there; and after their young fry have mingled with those of the carp, it will, if not absolutely impossible, still be exceedingly difficult to separate them. Spawning ponds should always have the same depth of water, and wherever it is possible be freely supplied with fresh water. If sky ponds are employed as spawning ponds, the opportunity to do this will of course offer itself but rarely. The spawning

*Horak, *Teichwirthschaft*, 1869.

ponds should be protected against inundations, and regard should be had to this matter when the ponds are selected. During winter, when the young fry is wintered in the spawning ponds, they need special supervision; and all the hints regarding the management of winter ponds given in another chapter should be carefully observed.

We have already referred to the quantity of young fry which may be looked for. The cause of variations in this quantity must be found in the fact that not all carp spawn at one and the same time, and in the circumstance that there are sometimes two spawning seasons. When taken from the ponds the young fry should be sorted, and if the quantity is sufficiently large, only the larger ones should be used for raising. The remainder should, if possible, be sold; and if this is impossible, they should be placed in the stock ponds to serve as food for the pike. If the selection of spawning ponds is not too much limited, these ponds should never be used as raising ponds, but. after the young fry have been taken out, they should be allowed to lie dry until they are again used for spawning. Von Reider recommends not to take all the young fry from the spawning ponds in autumn, but only to select the larger ones, and leave the remainder in the ponds to risk the coming winter. If there is a superabundance of young fry this is of course quite unobjectionable, as the very small young fry are not exposed to possible injuries during the fishing, the transportation, and the placing in the winter ponds, and are therefore likely to endure the severity of the winter. As a general rule, however, it will be impossible to avoid the catching of the very small young fry together with the larger ones, and all that can be done is to return the former to the waters of the pond. If this is done the pond should of course be filled with water immediately after the fisheries; and even during the fisheries sufficient water should be left in the fish-pits to prevent the young fry from perishing during the interval between the end of the fisheries and the filling of the pond. This method may be employed for ascertaining the capacity of a pond for wintering fish.

8. STOCKING THE RAISING PONDS.

The aim and nature of raising ponds has been described in a previous chapter, and it will, therefore, not be necessary to refer to it again.

The rapid development of the young fish into marketable fish will depend entirely on the character of the fish which are placed in the raising ponds and on the care bestowed upon the fish during the period of raising. The raising ponds are stocked with young fry, and with small or medium two years' fish, which have not grown large enough to be placed in the stock ponds. The successful development of the fish depends: (*a*) On healthy, strong, and perfect fish being placed in the raising ponds; (*b*) on the quality of the soil, the favorable location, and general character of the pond; (*c*) on the weather during the summer; and (*d*) on the proper number of fish for each pond.

To be able to stock properly the raising ponds, one should be thoroughly acquainted with their capacity of furnishing the necessary quantity of suitable food, taking proper regard to the location of the ponds and the temperature of the water. The first step will be to divide one's ponds into spawning, raising, and stock ponds; next the raising ponds will have to be divided into medium, good, and poor ponds, and these again should be classed according to their size. On well-regulated pond farms, which possess a sufficient number of ponds, the raising ponds will be divided into two classes; and in those of the first class the young fry, and in those of the second class the two years' fish will be placed. Wherever this is impossible, a three years', or at least a two years' course in the stock ponds will become necessary. For raising ponds of the first class it will be best to select small ponds, as they are more likely to supply the conditions upon which depends the rapid growth of the young fry, viz., quiet, the greatest possible degree of warmth of the water, and shallow, and extensive margins. Ponds, fed from rivers, brooks, or larger ponds, should be avoided as much as possible, so that the young fry may not be injured or entirely destroyed by fish of prey, which enter the pond from the above-mentioned sources. Although both the young fry and the two years' fish need good ponds for their successful development, it will nevertheless be advisable, whenever one has the choice between good and medium ponds, to place the young fry in the medium ponds, because experience has shown that it is injurious if young fry, which have come from spawning ponds having an abundance of good food, are placed in ponds where they find less and inferior food. This will retard their growth, because, unaccustomed to privations, they are unable to bear them. It is, therefore, necessary, if possible, to assign good ponds for the young fry, so as to afford them quiet, warmth, and ample food.

From the above it may be implied what kind of ponds should be selected as raising ponds of the first class for the two years' fish. As these fish are larger, they should also be assigned to larger ponds; or if this is impossible, the smaller ponds should not be stocked too heavily. From this it follows that the entire pond area for the second raising year should, in extent, exceed that of the first year, if the two-year-old fish are to reach their proper development. But there is another reason why the smaller ponds should be selected for the young fry, viz., because these little fish can move about with greater ease in their shallow grassy edges and thus make it possible to find food, in places where the two-year-old fish, owing to their greater size, could hardly go. In cases where it becomes necessary to stock such ponds with larger fish, it will be well, with a view to deriving the fullest possible benefit from these ponds, to place in them also some young fry. This should not, however, become the rule, but only be a rare exception, and on a well-regulated pond farm it will always be best to stock each pond only with one and the same kind of fish.

It will be as impossible with the raising ponds as with the spawning ponds to lay down definite rules as to the number of fish to be placed in them, and experience will prove the best guide in this respect. As a general rule one counts per hectare, in good raising ponds of the first class, 600 fry; in medium, 450; in poor, 300; in good raising ponds of the second class, 400 two-year-old fish; in medium, 300; in poor, 200. Regard should also be had to the weight of the fish, as even fish of the same age will but rarely have the same size and weight; for, apart from the influence of the varying nature of the ponds, fish, like plants, will not always thrive equally well if placed under the same conditions. If the ponds, however, have been carefully selected, this difference will make itself felt but slightly.

Horak* counts the following number of fry per hectare: In very good raising ponds, 622 to 833; in good, 519 to 622; in medium, 416 to 529; in poor, 210 to 313; in very poor, 103 to 154. Von Reider† places in ponds, which in case of necessity can be used as stock ponds, 1,500 to 3,000 per hectare, and in poor raising ponds only half that number; and Teichmann,‡ in medium ponds, 2,350 to 2,830 per hectare. Reimann§ says: "If a pond does not contain much food, I place in it 1,880 young fry per hectare; if it contains a medium quantity of food, 2,350; and if an abundance of food, 2,820."

We here miss the data as to the age of the fish, but considering the high figures, there is no doubt that young fry, or one-year-old fish, are meant. But even for young fry these are very high figures, and it may be stated as a fact that all the above-mentioned pond cultivators have, as a rule, raised marketable fish during a one year's course in the stock ponds. From this it may be inferred that in giving the above data they had no reference whatever to poor ponds. Raising ponds which have been sowed the year before can stand a comparatively larger number of fish than those where this is not the case. By arranging it so that every raising pond is sowed once in six years, the growth of the fish will be furthered considerably, and the main object, viz., to fit the young fish in the shortest possible time for the stock ponds, will be attained. If possible, the raising ponds should lie dry at least during winter. It is not always possible, however, to introduce a regular system of rotation in sowing the ponds or to let the ponds lie during the winter, for sheer necessity will compel many a pond cultivator to select for raising ponds ponds which consist of marshes and peat-bogs, and can, therefore, never be laid entirely dry, or which are used for industrial purposes, mills, &c., and can, for that reason, never be drained entirely. A system of rotation in sowing the ponds can only be introduced on pond farms which possess a very large number of ponds.

* Horak, *Teichwirthschaft*, 1869.

† Von Reider, *Das Ganze der Fischerei*, 1825.

‡ Teichmann, *Teichfischerei*, Leipzig, 1831.

§ Reimann, *Praktischer Abriss der Fischerei*, 1804.

The stocking of the raising ponds should begin in spring, when the weather commences to get warm and no more frosts need be feared. The young fish used for the purpose are taken from the winter ponds, or from the spawning ponds which have not been fished in autumn. The fry are measured out into kegs, which are not filled to the brim, and are conveyed to the raising ponds by reliable persons, who must remain near the ponds until the fish have left the edges, and also to see how many of the little fish have become weak or have perished during transportation. These observations should be repeated for several days, so as to repair any losses. The two-year-old fish should not only be counted, but also weighed, and the same precautions should be exercised as with the fry; but if the kegs are not filled too much with fish, and have a sufficient quantity of water, no loss need be feared, as the fish are strong enough to stand the hardships of transportation. In raising ponds it will be well to add a few tench, which by rooting in the ground will make the food hidden in the mud accessible for the fry and two-year-old fish. In these ponds there should also be placed some three-year-old carp as "leaders," particularly in raising ponds of the first class. These so-called "leaders" are to draw the attention of the younger fish to threatening dangers by flying to the depths, whither the young fish will immediately follow them. If the raising pond contains winter quarters, these three-year-old fish will also lead the young fish there; and it will be necessary to add a few such leaders in winter ponds containing young fish.

The fisheries in the raising ponds generally begin in October, and somewhat earlier on large pond farms, so as to get through before frost sets in. Horak says that large and deep raising ponds which have an ample and constant supply of water may be omitted in the autumn fisheries and be fished in spring, thus saving time and money. From the raising ponds the fish are transferred direct to the stock ponds. The omission of large raising ponds from the fisheries is only advisable if these ponds afford absolutely safe winter-quarters for the fish, and only when the pond cultivator is overtaken by an unusually early winter.*

9. STOCKING THE MAIN OR STOCK PONDS.

In selecting the stock ponds two conditions will have to be considered, which are but rarely combined. In most cases large, even very large, ponds will have to be selected, principally because these large ponds, owing to their size, depth, the low temperature of the water, and the introduction of other fish—caused by their being generally fed direct by rivers and brooks—which rob the carp of their food, will not be suitable for young fish or fry. Stock ponds will need some fish of prey to destroy the intruding fish, and they should have an ample supply of the very best food, so that the fish may become marketable after one year. In large ponds, however, the supply of food will not be as ample

* Horak, *Teichwirthschaft*, 1869.

as in small ponds, even if the nature of the soil is the same. In fulfilling the first condition of a stock pond, viz., that it shall be large, it will become difficult to fulfil the second, viz., to have an ample supply of good food. It should therefore, be the aim of the pond cultivator to stock the stock pond in due proportion to the quantity of food contained in it, and thus make sure of sufficient food for the fish. The main points in the selection of stock ponds should always be sufficient depth and an ample and constant supply of water, so as to insure the safety of the fish during winter; and it will therefore, under all circumstances, become a matter of necessity to select large ponds for stock ponds.

We have already stated that the main object is to make the fish marketable in as short a time as possible. The shortest time in which this is possible is four years—not five or six, as is customary on most pond farms. If this object is attained, pond culture may be said to have been entirely successful. Delius says very truly: "We often meet with ponds in which the fish are left three years; but this is evidently an error. No pond can possess the necessary conditions of food for three years, and the total loss, if 10 per cent per year, will be very considerable. This loss may be avoided in a two years' course if the number is proportioned exactly to the conditions of food. It is exactly as in stock-raising, the quicker an animal is raised and fattened the greater will be the gain. A certain quantity of the food is needed for sustaining life, and everything above that quantity goes towards fattening the animals. Although with fish the quantity of food needed for sustaining life is smaller than with cattle, it will nevertheless make a great difference whether this quantity has to be counted for one or for three years. In a very good pond it will be easy to make suitable arrangements in this respect. To obtain favorable results, it should be ascertained what will be the annual increase of weight (in pounds) in a pond; and from this it can be calculated what number of fish should be placed in it to obtain the best possible results. The case will be different in poor ponds; if the supply of food is not very abundant, it will take several years to raise the carp to a certain size. In this case it will be found advantageous to stock the pond with three and four year old fish (mixed), and fish it every year, which will make it possible to place the proper number of fish in the ponds. If the pond requires a three years' course, three classes of fish (according to age) should be placed in it, and the oldest sold every year. The result will then be better than if one class of fish is allowed to remain in the pond for three years."*

I have given the above quotation verbatim, because I could not have expressed my own views better. I think, however, that even in a poor stock pond the three years' course may be avoided if the young fish have previously been properly raised and are not placed in the stock ponds unless they weigh 1 pound apiece, which weight carp can reach in three years in medium and even in poor raising ponds if these have

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* Delius, *Teichwirthschaft*, p. 63.

been stocked in proportion to their capacity. It will rarely occur, especially in large pond farms, that all the ponds are poor. Even if the stock pond is poor, but the raising ponds good, the carp can in these acquire the necessary weight so as to become marketable after two years in the stock ponds. If placed in the stock ponds when weighing 1 pound apiece the carp will in one, and certainly in two years, reach the marketable weight of 2 or 2½ pounds. If the pond is stocked in due proportion to its capacity it may even reach a greater weight in two years. But, as Delius says,* there is no special advantage in raising carp to a greater weight than 2 to 2½ pounds, it being more profitable to sell the carp as soon as possible, even if they should weigh only 2 or 2½ pounds, than to raise them to a weight of 4 or 5 pounds, which would require five or six years. For to the carp cultivator, as to the stock raiser, applies the old adage: "Too long a period of raising, the total quantity of food being the same, will yield but small profits." It will, under all circumstances, be more profitable to produce a certain number of marketable fish in a few years than a larger number in a longer period. To obtain the desired result the ponds should rather be under than over stocked. The most profitable method will always be the one by which carp can be marketable in four and not in five or even six years. To attain this should be the aim of every rational pond cultivator. In endeavoring to reach this object he may meet with unavoidable difficulties, but if proceeding systematically he will always be able to raise marketable fish in five years, even in medium, and occasionally also in poor ponds. If he needs six years, he must have made mistakes in the selection, stocking, and management of his raising ponds.

I therefore repeat what I said under the head of raising ponds: It should be the principal aim of the pond cultivator to shun no trouble and care, to raise only healthy and strong fry and young fish; for a single mistake may frustrate all his plans, and disturb even the best system to a degree that it may take years to repair the damage. If the pond cultivator has done his duty by his raising ponds, he will in due time reap his reward in the stock ponds. Horak says: "Carp ponds with a one year's course are but rarely profitable; the aim should be, therefore, to have only ponds with a two years' course, and to avoid a three years' course." He endeavors to prove his assertion as follows: "The location of the pond, and the nature of its soil and water have a decided influence on the length of time which will be required to raise the fish to their proper weight. There are only a few ponds in which the young fish, which generally remain in medium ponds three summers, will become marketable fish in two or even one year. Such results can only be looked for in exceptional cases, in particularly favorable years, and after the pond has been sowed, for as a general rule the large three-year-old fish will need three summers, and the two-year-old fish one summer to become marketable fish. After having been sowed, only

* Delius, *Teichwirthschaft*, p. 64.

the best ponds are given a two years' or one year's course, by placing in them only three-year-old fish."*

The above may apply to very large pond farms like that of Wittingau, which has a total pond area of 6,000 hectares, raising ponds of 7 to 50 hectares, stock ponds of 100 to 500 hectares and more, and a total number of about 300 ponds, for not only will the conditions of soil vary much in the different ponds, but there may be great differences in this regard in one and the same pond, thus causing a difference in the growth of the various classes of fish. But the above may apply at Wittingau also on account of the great size of the individual ponds, as it is a rule—and exceptions only go to prove the rule—that large ponds do not seem as favorable to the raising of fish as small ponds; and it may, therefore, frequently happen at Wittingau that the one year's fry do not, in the second year, reach the minimum weight of half a pound apiece, and do not reach the minimum weight of 1¼ pounds in the third year, in which case all that can be hoped for is that the fish, during one year in the stock pond, will reach the weight of at least 2 pounds. It is therefore considered a satisfactory result at Wittingau if the average result of the raising ponds of the first class is 30 to 33 pounds per 100 fish. Under ordinary circumstances the fish will in the second raising year not reach the weight which would enable them to become marketable during one year spent in the stock pond. There is only the alternative to let them pass through another raising pond, or to let them remain two years in the stock pond. If this should on some pond farm occur very frequently, or even become the rule, it would have to be considered a miscalculation if the one year's course in stock ponds was introduced, and it will under all circumstances be the safest plan to have only stock ponds with a two years' course. On medium-sized pond farms there is no necessity whatever for stock ponds with a three years' course.

It is an old adage that what is good for big folks is not always good for little folks, and, as the vast majority of pond farms are small, we shall not deviate from our program, and take for our motto, "The highest aim of a pond cultivator is not to have two years' but one year's stock ponds." Von Reider advocates, as a rule, only stock ponds having a one year's course. He says: "Those stock ponds are the best which can be fished clean every year; but, in order to accomplish this, one should be able to raise every year the necessary number of fish for stocking them, and consequently have as many raising ponds as this requires. Such ponds should have a constant supply of fresh water, so that they can every year be filled as soon as needed, and there should be no cause for shunning the expense of the frequent fisheries. Only very large stock ponds are fished clean every two years, as it may be difficult to fill them; or, in case there is a lack of raising ponds, making it necessary to use some of the stock ponds for this purpose; or, finally, where it is desirable to avoid the expense of annual fisheries. To use

*Horak, *Teichwirthschaft*, 1869.

stock ponds partly as raising ponds is generally an indication of disproportion between the raising ponds and the stock ponds. It will therefore be well at the very start to classify the ponds, properly assigning enough of each class for the purpose which they are to serve, and make a point of having every year a full supply of two years' fish (not counting the year in the raising ponds) for stocking the stock ponds. Where local circumstances forbid this, the inferior stock ponds should also be partly used as raising ponds, or have stock ponds with a two years' course. The stock ponds are, therefore, stocked with fish which have spent one or two years in the raising ponds, but only in such a manner that those stock ponds which are fished clean every year are stocked with two years' fish, and those which have a two years' course with one year's fish. In exceptional cases, however, if the stock ponds are particularly good and there is a lack of fish, they may be stocked with one year's fish and fished clean in autumn, when, supposing that there is sufficient food and ample room for the fish, a satisfactory yield may be expected in every case. The largest fish must be selected for stocking the stock ponds, and, even if in these ponds they do not reach the largest possible size, there will nevertheless be some profit."*

There may be cases where circumstances not at all connected with the pond farm may necessitate a two years' course in a stock pond, *e. g.*, when the water has also to serve industrial purposes, mills, &c. In such a case the profits of annual fisheries would not compensate for the losses occasioned by the stoppage of a mill or factory, and all that can reasonably be looked for is to raise marketable carp weighing 3 or 4 pounds. Although it should be the aim of every rational pond cultivator to make his young fish marketable as rapidly as possible, it would be an erroneous and irrational proceeding to finish the course of development with the third year, and bring to market three-year-old carp weighing on an average only 1.5 pounds apiece. I feel compelled to call special attention to this matter, because experience has shown that there are pond farms where such irrational methods are followed, in the belief that a good business is being done. It does, therefore, not seem superfluous to show the unreasonableness of such a course by giving a brief sketch of an imaginary pond farm of small size, where, deluded by a ready market for carp weighing 1.4 to 1.6 pounds—it probably being impossible for the consumers to get carp weighing 2 pounds anywhere in the neighborhood—the proprietor follows the above system, and comparing therewith another brief sketch of a systematic pond farm selling three-year-old carp weighing 1.5 pounds apiece, and finally offering for further comparison the sketch of a farm selling four years' fish with a minimum weight of 2 pounds apiece.

We suppose the pond farm to have eleven ponds, with a total area of 700 ares, the largest pond covering 220 ares, and the smallest two 6.8 and 8.5 ares, the remainder varying from 35 to 92 ares. The ponds

* Von Reider, *Das Ganze der Fischerei*, 1825.

are all of the best kind. Managed without any system, they yield annually 300 pounds of carp, each fish weighing 1.4 and at most 1.6 pounds. By systematizing the management of this farm according to the principles laid down in previous chapters, the result will be about as follows: One-seventh part of the 700 ares, therefore 100 ares, are allowed to lie dry for sowing. The other 600 ares are to be utilized in the following manner:

Ponds.	No. of ares.	Number of fish.			
		Minimum per are.	Total.	Average per are.	Total.
10 per cent spawning ponds	60				
30 per cent raising ponds	180	1.8	324	2.7	486
45 per cent stock ponds	270	1.2	324	1.8	486
15 per cent winter ponds	*90				

*Of the area of winter ponds given here, a part may be used for raising purposes, but in the present scheme this need not be taken into consideration.

On the above basis of stocking, the yield in the third year will be: In poor ponds, 324 fish at 1.5 pounds=486 pounds; in good ponds, 486 fish at 1.5 pounds=729 pounds.

In managing and stocking the ponds on the basis that the fish are not to be sold till the fourth year, when they have reached a minimum weight of 2 pounds apiece, the scheme would be as follows:

Ponds.	Number of ares.	Number of fish.			
		Minimum per are.	Total.	Average per are.	Total.
6 per cent spawning pond	36				
15 per cent raising ponds of the first class	102	3.0	306	4.5	460
25.5 per cent raising ponds of the second class	153	2.0	306	3.0	460
42.5 per cent stock ponds	255	1.2	306	1.8	460
9 per cent winter ponds	54				

On this basis the yield in the fourth year will be: In poor ponds, 306 fish at 2 pounds=612 pounds; in good ponds, 460 fish at 2 pounds=920 pounds. But in the fourth year we may count on some pike, equal to at least 5 per cent of the stock of carp, in round figures 30 to 45 pike at 2 pounds; therefore, a total quantity of pike of 60 to 90 pounds. The grand total of the yield will therefore be: 612 pounds carp + 30 pounds pike=642 pounds, and 920 pounds carp + 45 pounds pike=965 pounds; consequently an excess over the sale of fish weighing 1.5 pounds apiece of 156 and 236 pounds, respectively; which excess, owing to the fact that in all probability the carp in the fourth year will have reached an average weight of 2.37 pounds apiece, will be increased to from 300 to 400 pounds.

It should of course be taken into consideration that this favorable result in the fourth year is attained one year later than the smaller yield

of the third year, and that, therefore, in starting a pond farm three years instead of two are without result, and also that when the change is made from the three to the four years' period, one year will be without any profit; but by the surplus of the fourth and fifth year this difference is equalized; and from that time on the farm will annually yield a surplus, mainly caused by its reorganization. It further follows from this that the productiveness of a pond farm will greatly depend on using a rational method; for the same results as those given above have been attained in practice by reorganizing a large pond farm, where, without increasing the total stock of fish, the yield was doubled. It is therefore a great mistake to sell three years' carp weighing about 1.5 pounds apiece, while that method must be considered the most rational by which the pond cultivator succeeds in raising in two years carp weighing two pounds and finding a ready market for them. The fish which are to form the stock of the stock ponds are taken from the raising ponds.

The number of fish to be placed in the stock ponds depends on the nature of the soil, the quantity of food, the location, and water supply of the pond, and on the age and weight of the fish to be placed in it. Von Reider says: "The number of fish to be placed in a stock pond depends solely on its capacity for furnishing food; good ponds should be stocked at the rate of about 230, and poor ones of 150 fish per hectare. But if fish which have only spent one year in the raising pond are placed in stock ponds which are fished clean every year, only 230 fish should be counted per hectare. In order, however, to derive still greater benefit from large stock ponds, the number may be still lower; but if this is done no fish of prey should be allowed in the stock ponds. But this should only be done if one thinks that the losses would be greater if more fish were placed in the pond."*

Reimann says: "Every square rod of stock pond area should receive one carp from the raising ponds; the age of such carp should be three years; medium stock ponds should receive one carp per 1½ square rods (*i. e.*, per hectare, 470 and 310, respectively), and poor stock ponds should receive 1 three-year-old carp for from 2 to 3 square rods (*i. e.*, per hectare, 150 and 230, respectively)."

Reimann says in another place: "Some people take, as a general rule, for a one year's course in the stock ponds, carp weighing fully one-half pound apiece, and, if possible, those which have reached the age of three years, and for stock ponds which are fished clean every year carp weighing 1, 1¼ to 1½ pounds, also three years old. According to the greater or less size of the stock ponds, and their greater or less capacity for furnishing food, such people will stock a pond area of 120 square rods with 60, 50, 45, and sometimes with only 40 fish (*i. e.*, 240, 200, 180, 160, respectively, per hectare)."†

The proper time for stocking the stock ponds is autumn, immediately

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* Von Reider, *Das Ganze der Fischerei*, 1825.

† Reimann, pp. 86, 87.

after the fisheries in the raising ponds have come to a close. If there is no trouble about filling the stock ponds in spring, and if there is a sufficient area of winter ponds, it may sometimes be advisable to let the stock ponds lie dry during winter, and to cart away the mud. If there are any stock ponds which, after the close of the autumn fisheries, cannot be filled immediately, or at least not to their full depth, they should not be fully stocked at once, but the number of fish placed in them in autumn should be in proportion to their quantity of water, and in the following spring they should receive their full stock of fish from the winter ponds. If there are stock ponds with a two years' course, which cannot be entirely filled in the time from autumn till spring, and which therefore do not receive their full supply of water till the second year after the fisheries—which often happens in large sky ponds—the number of fish should not be proportioned to the entire area of the pond, but to that portion which is filled during the first year; and this number of fish should not be increased during the second year, for at that time the pond, as a general rule, cannot supply the grown fish with the food which they need for their further development. It will therefore be an advantage if during the second year the fish get for their pasture-grounds the edges of the pond which hitherto have lain dry, but which are now filled with good food. If the number of fish was doubled, both the old inhabitants of the pond and the new-comers would suffer want, and therefore undoubtedly be retarded in their growth.

The transportation of the fish to the stock ponds should be intrusted to thoroughly reliable persons, so that the losses at the time of the fisheries may not be too large, and the hopes of the pond cultivator may not be too severely disappointed. In stock ponds which have a two years' course, regard should be taken to the age of the fish, because if three years' fish are placed in such ponds, they will spawn when they reach the age of 4 or 5 years, and the food will have to be shared by the old and young fish, in consequence of which the former are retarded in their growth. But if a suitable number of fish of prey is placed in the ponds, which do not let the young fish grow up and hinder the old ones from spawning, less harm will result from placing in the ponds fish which have reached too great an age. It may be laid down as a rule, however, that by spawning a carp is invariably retarded in its regular growth.

Horak enumerates the following reasons why carp spawn in stock ponds: (1) If old or crippled fish, or such as have not been hatched in spawning ponds, are placed in the stock ponds; (2) if the summer is particularly warm, and has much calm weather; (3) if there is too much food in the pond; and (4) if no pike are placed in the pond, or if those which were contained in it have perished from want of proper food or have destroyed each other. Horak thinks that the pike prevent the carp from spawning, because they constantly see before them the bitterest enemy of their young ones. According to my experience I am in-

clined to doubt this, although there may be a grain of truth in it, for on what should the pike live, especially in a sky pond, if not on the young of the carp. I had 10 per cent pike in four large stock ponds (sky ponds), which in two years grew to a very respectable size, although besides the carp there were in these ponds only a few tench, on whose young ones, in addition to the poor fry of carp from the raising ponds, the pike could not possibly live and reach, as they did, a weight of 4 to 6 pounds. It must, therefore, be supposed that if not all, at any rate the greater portion of the carp, had spawned, and thereby furnished ample food for the pike. If the carp had not spawned, no young fry could have been fished from the pond, and the quantity taken therefrom was very considerable.

The stock ponds are generally fished in October; but the fish may also be allowed to remain in them during winter, and the fisheries take place in spring or summer, if there is reasonable hope that at that season the fish will fetch a higher price than in autumn. The losses, however, which are unavoidably connected with summer fisheries, will in most cases neutralize any possible gain caused by the higher price of fish. Summer fisheries should always take place in the cool of the morning, and with as much expedition as possible. One should always be prepared for considerable losses in the stock pond fisheries. We have already, in a previous chapter, spoken of the average amount of the losses during the fisheries; but it may be useful to quote Von Reider on this subject. He says: "In the stock ponds one should always count on some losses, although it will be impossible to determine their extent beforehand; for a great deal will depend on the location of the stock ponds, whether they are surrounded by forests, in which case birds of prey will make havoc among the fish, whether there is much thieving going on in the neighborhood, whether there is danger of inundations, &c. According to these varying circumstances one should always count as loss one-tenth to one-twentieth of the number of fish placed in the ponds. Some people always count the loss as one-fifth, and therefore overstock the ponds very much, which, however, does more harm than good, as it deprives the fish of sufficient room and food, and keeps them small. It will be better to understock than overstock the stock ponds, and if there are too many fish on hand from the raising ponds, it will be better to sell those which are not needed."

As the largest ponds are generally selected for stock ponds, the food which they offer is, as a rule, of a more varied character than in small ponds; and with the view to derive the greatest possible profit from them, it will be advisable to stock them with some other fish besides carp. Large stock ponds not only offer a larger variety of worms and insects, thus providing the proper food for different kinds of fish, but also they generally receive their supply of water from rivers and brooks, when, in spite of the grates, fish of all kinds will get into the ponds. Such fish are of no direct value to the pond cultivator, and can be util-

ized only by feeding them to fish of prey, which are certain to find a ready market. As has already been stated, the older carp like to spawn in the stock ponds; their young ones will likewise decrease the quantity of food, and it will become necessary to destroy these young fish, which is easily done by placing in the pond a number of fish of prey. Among the fish of prey the pike deserves the preference on account of its voracity, its rapid growth, its hardy nature, and its ready sale; and from time immemorial it has been and is still the constant companion of the carp in the stock ponds. Care should be taken, however, that the pike do not exterminate the carp, and only pike of such a size as to make it impossible for them to outgrow the carp should be placed in the stock ponds. The pike is the most inveterate enemy of the carp, and will destroy it whenever possible. The number of pike, or other fish of prey, will depend on the quantity of food supplied for them, and on the number of carp in the pond. When ponds are fished which contain both carp and pike, great care should be exercised that no pike of any considerable size remains over till the following year, for a single large pike is capable of making sad havoc among a stock of carp. Carp weighing 1 pound should be accompanied by pike weighing at most one-quarter pound, and carp weighing 2 pounds by pike weighing at most one-half to three-quarters of a pound apiece. The same applies to other fish of prey, *e. g.*, perch, &c. To every 100 carp one generally counts 10 to 15 fish of prey.

Of other fish the tench are best suited for stock ponds, especially in a neighborhood where they find a ready market. The same price is often paid for them by dealers as for carp. If not placed in the ponds in excessive quantity the tench have the advantage that they can live on food hidden in the mud, which is not accessible for the carp, and that by their rooting in the mud they dig up food for the carp which these otherwise could never get at. A large quantity of the young fry of the tench serves as food for the pike. The *Idus melanotus* may also prove a valuable addition in carp ponds, as it often finds a ready sale as an ornamental fish. It will be well not to place too many other fish in the stock ponds, and their number should be deducted from the number of carp to be placed in the pond.

10. CARE OF THE FISH, ESPECIALLY THE CARP.

The care of the fish consists—

1. In keeping the pond in good order, which is done: (*a*) By keeping the dikes and banks in good repair, and by regulating the supply and outflow of the water; (*b*) by keeping the water always at a proper height.

2. In providing not only sufficient but good food for the fish, which may be done: (*a*) By artificially improving the capacity of the ponds for producing food; (*b*) by feeding the fish artificially.

3. By exercising careful supervision over the ponds, both in summer

and winter, so as to keep away from the fish all enemies and hurtful influences.

Keeping the dikes in repair.—The proper depth of water will principally depend on the character of the dike. It should therefore be one of the main objects of the pond cultivator to keep the dikes constantly in good repair. For this purpose they should be carefully examined from time to time, and any damage that is discovered should be repaired at once. The most suitable time for making repairs is after the autumn fisheries. When the water has been let off the dike should be carefully examined; any damage which is found should be repaired without delay, and if considerable the work should go on, as the weather permits, until it is completed. If it is impossible at the time to make thorough repairs, something should be done to prevent the spreading of the damage, and the thorough repairs should be made as soon as practicable. Small breaks in the dike are most quickly repaired by ramming in piles below the damaged place on the water side, by filling the space between the dike and these piles with small willow fascines, and by covering the whole closely and firmly with sod. Holes in the dikes and banks are filled with earth and clay mixed with stones. Teichmann says on this subject: "If water penetrates the dike in one or more places, this should be immediately remedied, for if there is great pressure the water will soon widen out the holes and break through the dike. In this case loamy or clayey soil should be piled upon the water side, wherever holes are found, and the evil thus be checked. Manure mixed with straw may sometimes answer the purpose. If by employing one or the other of these remedies the holes cannot be entirely stopped up, extensive repairs should be made as soon as the fisheries are over. Wherever the dike has suffered any damage it should be dug up, and if the soil has not much consistency it should be mixed with loam or clay and rammed down firmly. The mended place is covered with pieces of sod. If the pond is large, and the waves strike the covering of sod violently, it may be well to construct a fence of willow branches in front of the mended place and fill the space between it and the dike with earth."*

These hints for repairing dikes must suffice, as any one who has carefully studied the chapters treating of the construction of dikes will easily find ways and means for making all the necessary repairs.

After the fisheries are over, the outflow-pipes, taps, and stand-pipes should also be carefully examined, and repairs be made wherever needed. The weirs and grates should likewise be examined, and if necessary be repaired or renewed. The ditches should be cleaned of mud and aquatic plants.

Keeping the water at a proper height.—To do this it will be necessary to keep up a constant and even supply of water from the outside, and regulate the outflow after the pond has received its full supply. The best plan will be to introduce into the ponds clear running water from brooks

*Teichmann, *Der erfahrene Fischmeister*, 1821.

and springs or from ponds which are fed from these sources. To obtain an even influx and outflow it is above everything else necessary that all the ditches should constantly be kept in good repair, and from time to time, especially after the fisheries, be cleaned of mud and aquatic plants. There is but little difficulty in keeping up a regular influx of water, if the ponds are fed from brooks and rivers, and by weirs and sluices this can easily be regulated. It is different in sky ponds, whose supply of water depends on the accidental gathering of rain and snow water in fields and meadows. Here it will become necessary to keep the ditches through which the water enters the pond in particularly good repair, to construct a large number of these ditches, and even, if necessary, to bring the water from a distance. If any roads or dikes are in the way, the water should be carried underneath them through pipes or conduits, while it may be led round small elevations. As the water in these ponds is apt to be stagnant, and as a slight agitation favors the absorption of oxygen from the air and thereby makes the water healthier for the carp, the desired object is attained by letting the water flow into the pond over a weir, so that by its rushing motion it keeps up that constant movement of the waters of the pond which is beneficial to the fish. To substitute weirs for grates may be recommended in all those ponds which are fed by small streams or springs. If ponds are fed by brooks or rivers, the pressure of the water on entering the pond is generally stronger than may appear desirable for the fish, and in this case, therefore, it will be preferable to let it flow in through grates. For keeping the water at an even height the stand-pipe may be recommended, of which we have spoken in a previous chapter.

Cleaning out the mud.—To insure an even height of water, and a regular supply and outflow, no mud or aquatic plants in the ditches should offer any hindrance to the water in its flow. After the fisheries, therefore, all the ditches should be carefully cleaned. It is true that the mud contains a great deal of nutritious matter, while the aquatic plants not only serve as food for fish but also sustain many insects which form a favorite article of fish-food; but it cannot be denied that too great an accumulation of mud and too rank a growth of plants will contract the water area very preceptibly, and thus prove injurious to the fish. To clean a pond of superfluous mud and aquatic plants, it will be necessary to drain it and dig ditches through the mud which should all open into a main ditch and carry the water towards the outflow. The mud taken from the ditches is piled up in heaps and allowed to dry in the sun and air. These mud piles are not carted away till winter when the ground is frozen, and should then remain exposed to the influence of the atmosphere for at least a year before they can be used as a fertilizer. This has also the advantage that the mud decreases at least one-half in volume and weight, and offers much less difficulty in carting it to the fields than if it had to be moved in its moist condition.

The mud is removed from the different parts of the pond to its banks

in wheelbarrows, and in very large ponds one-horse carts may be used, from which the mud can easily be dumped. In removing mud from a pond, special care should be taken to do this evenly throughout the entire pond, so as to prevent the formation of holes in the bottom, which would seriously interfere with the fisheries. It would, however, be a mistake to remove every particle of mud from a pond, as this would diminish its food-producing capacity, but it should always be allowed to remain to the depth of 30 to 40 centimeters. If the mud is to be taken from very large ponds, it will be impossible to accomplish this by carting it away, as this would involve too much labor and expense; and it will become necessary, immediately after the fisheries, when the mud is still in a fluid condition, to have it carried away with the water. To do this, running water should be led to the deepest places; or special ditches should be dug, to which the mud is carried from all sides, and whence the water carries it farther, and finally out of the pond through the pipes, which process should be aided by rakes, shovels, and brooms. This process will of course, require rapidly running water, whose course may be accelerated by occasionally driving in the tap and quickly pulling it out again. This process should be continued until the pond has been sufficiently cleaned of mud. If possible, the bottom of a pond which has undergone this process should be plowed, and not be allowed to dry out, but should be immediately filled again with water.

Sickness among fish.—By cleaning the pond annually and by aiding the influx of water, the health and growth of the fish will be greatly promoted. If the water is very low, and if there is too great an accumulation of mud in the pond, the temperature of the water will, in hot summers, become too high, too much oxygen will be absorbed, the decay of vegetable and animal matter will be very great, the water will deteriorate, the fish will perish, unless either a timely supply of fresh water is introduced into the pond or the windows of the sky are opened and help comes from above. To this danger fish are particularly exposed in sky ponds in which it is difficult to keep up an even height of water, and among these the smaller and shallower ponds are apt to suffer more than the larger ones. This danger will be greatest during the months of June and July.

This condition of affairs is indicated by various signs; the fish swim about near the surface of the water endeavoring to get a breath of air, they become languid, lose their natural color, and finally perish. If at the first signs of such a catastrophe it is impossible to introduce fresh water into the pond, and if there is no hope of rain, nothing remains to be done but to commence the fisheries at once, and transfer the fish to fresh water. It is true that by the fisheries the mud is stirred up, and the water is consequently still more deteriorated, thus increasing the danger, but of two evils the smaller one must be chosen, and all the fish which can be saved should be saved. Such fisheries, however, should not take place during the heat of the day, but at night. In small ponds

aid may be afforded, and the worst consequences averted, by throwing black soil, if it can be obtained in the neighborhood, into the pond, until it is covered to the height of 7 to 10 centimeters. Thereby the pond is again rendered healthy, and the fact that the water becomes turbid need not alarm any one, for no fish will perish from this cause. On no condition whatever should such a pond be drained, for thereby the mud is stirred up, and the evil is made worse.*

Horak is also of opinion that the stirring up of the mud makes matters worse, and considers fisheries as the only remedy. He says: "If animal refuse is carried into ponds located in the middle of or below villages, or if cattle are driven into them, the accumulated organic matter will, during hot summers, particularly during the months of June and July, begin to ferment, and will thereby cause the death of the fish."† A pond in which a large number of fish have died should be drained and sowed.

Unless the water sinks too low, an extraordinary supply of water should in no case be introduced into a pond, as this will invariably drive the fish away from their pasture-grounds, disturb them greatly, and cause them to go towards the fresh water which flows into the pond. If it is absolutely necessary to introduce a fresh supply of water, this should be done slowly and gradually. Wherever there is fear of inundations, which generally take place in spring, but also at other seasons, in consequence of violent or long-continued rains, there should be plenty of ditches for superfluous water, which should always be kept clean, so that they may receive the greatest possible quantity of water. If the danger of inundation is imminent, the pond must be constantly watched, the grates and weirs should frequently be examined, and persons should keep watch all through the night, especially if there is any fear of thieves approaching the pond, for inundations carry the fish towards the fresh current and offer them a chance of escape from the pond. Unless proper precautions have been taken, the fish will, during an inundation, scatter all over the neighboring country and will get lost or stolen, unless they are gathered as soon as the waters commence to recede and are returned to the pond. In gathering fish which have become scattered in the manner described above, search should be made for holes in the ground, where the fish will naturally go, for there are not unfrequently neighbors who, on such an occasion, will dig holes with a view to catch the fish.

Improving the food-producing capacity of the ponds by artificial means.—(1) The safest way to keep up an ample supply of good food, to introduce new food into the ponds, and thereby to improve them, is to drain and sow the ponds at certain stated periods; in other words, to use them for a time for raising grain or grass. After a pond has been fished clean and the water drained off, ditches should be constructed in it in every direction,

* Von dem Borne, *Fischzucht*, p. 74.

† Horak, *Teichwirthschaft*, 1869.

so that the water may be entirely taken out, and the bottom allowed to dry. In this condition the ponds are left till spring, say April or May, when they may be plowed and prepared for the seed. To insure a good harvest, the entire bottom of the pond should be divided into raised beds, separated from each other by water furrows. These beds may be sowed with oats, hemp, or poppies; other grains or plants will yield only poor harvests. After the harvest has been gathered, the soil should be hoed, and allowed to remain in this condition till the following spring, when the pond is again filled. If it is not intended to gather a harvest, but simply to supply the pond with plenty of fresh food, it is plowed in spring and allowed to lie fallow till summer, when it is sowed with turnips. Still better food will be introduced into the pond if it is sowed with peas, beans, and vetches, with a few turnips between. In this case there is no hurry about sowing the pond, and this may be deferred till June, or till July if only turnips are sowed. When the peas and turnips are nearly ripe, the pond is filled with water, and may be stocked with fish that same autumn, although it will be better to defer this till spring. In most cases, however, it will be best to gather the harvest, as the decay of vegetable matter easily assumes too great proportions and becomes injurious to the fish. This applies particularly to small ponds. Even if the harvest is gathered, the sowing of a pond will be of great benefit, and make its influence felt for years. For during the time of growing and during the harvest many seeds fall into the pond, and to favor this one may defer the harvest until the grain or plants are dead ripe. Even the stubbles in themselves form an addition to the food. By sowing a pond, food is also indirectly introduced into it by giving it a period of rest, during which worms, &c., will increase. In their decay the stubbles also furnish food; and the thorough freeing of the soil from acids caused by the draining and sowing of a pond has a most beneficial influence on the health and growth of the fish.

The object of sowing a pond is twofold; the acids are taken away from the mud by the draining and plowing of the pond, and new food is introduced in it, and, on the other hand, an additional income is derived from the sale of grain or vegetables. To sow a pond for one year will be beneficial, but to continue this process for several consecutive years is not advisable, as the pond is apt to dry out too much, and loses its mud, which is indispensable to the growth of the fish. The banks and dikes also dry out too much—the latter are undermined by mice, moles, &c.—the wood-work of the grates, &c., suffers, and repairs become necessary, the expense for which is not sufficiently made up by the income from the harvests. By using a pond for agricultural purposes for any considerable length of time its fish-food is reduced almost to nothing (this is less to be feared when the pond is used merely as a meadow, which, however, will yield only poor and sour grass) and the benefit to be derived from sowing a pond is completely lost.

If a pond yields constant and sure harvests, and can also be used for

winter grain, it will pay better to transform it into a field. Teichmann is of the same opinion when he says: "One of the most efficient means for improving a pond is undoubtedly in all cases to let it lie dry for a year and to utilize it during that period by raising grain; for it has invariably been observed that after a year when the pond had been used for agricultural purposes the fish grew remarkably well, even if a much larger number was placed in the pond than it could otherwise support. If a pond which had been sowed for a longer period is to be filled with water, the number of fish must gradually be reduced, and even brought below the average, if they are to reach the desired size. The beneficial effects of sowing make themselves felt for six years, and in some cases even longer. The sowing of the ponds is, so to speak, a rejuvenating process. It will depend on the various localities how often ponds should be sowed. In some places the ponds, not even excepting very large ones, should be drained every sixth year and sowed with oats. Sowing is the most effective means for destroying frogs and other injurious animals. It is not advisable to use ponds for agricultural purposes several years in succession, for in that case mice and other animals are apt to undermine and injure the dikes, and the long dry period would also injure the tap-houses, grates, &c." *

Experience should gradually teach how often it will be necessary to sow a pond. Sowing repeated at considerable intervals can never be injurious, and will under all circumstances exercise a beneficial influence on fish-culture and the general condition of the ponds. These intervals should not be longer than ten and not shorter than five years. In drawing up a plan for the management of a pond farm, it will sometimes be found impossible to determine the length of these intervals. If they are not less than five and more than ten years, it will be better to adapt oneself to circumstances than to sow pond areas of greatly varying extent every year, as this will in most cases interfere with the regular management of the ponds. If the ponds are few and large, it will be difficult to introduce a regular system of sowing.

(2) Another way to introduce food into the ponds is to lead rain and snow water from cultivated fields, which always contain much fish-food, by means of ditches into ponds which are fed by brooks or springs. In sky ponds it will be absolutely necessary to do this.

(3) The accumulation of food is favored and the general condition of the ponds is improved if after the autumn fisheries they are allowed to lie dry till spring. If it is in any way possible this should be done. It will, of course, depend on the possibility of filling the pond in spring. Whenever a pond is allowed to lie dry one should not forget to remove the mud.

(4) The production of food is greatly promoted by the planting of various kinds of grass and aquatic plants, *e. g.*, *Acorus calamus*, *Festuca fluitans*, and other plants whose young shoots, seeds, &c., serve as food

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* Teichmann, *Teichfischerei*, 1831.

for fish, and of such plants as are inhabited by aquatic insects, &c. The *Potamogeton*, *Glyceria*, *Spectabilis*, *Ranunculus aquatica*, *Trapa natans*, &c., are generally covered with these insects. The planting of reeds in bare places will also render the pond better suited for fish and improve its general condition.

Feeding carp artificially.—The sowing of the ponds may be considered as a means of providing artificial food, but in a narrower sense we understand by artificial feeding the introduction of food which the pond cannot produce. Artificial feeding will be difficult if the pond farm is very extensive; and if all the ponds are very large it will be impossible. There are, however, many medium and small pond farms which, besides large ponds, possess also a number of small ponds, in which the system of artificial feeding may be introduced. It is the object of artificial feeding to increase the weight of the entire stock of carp, or a portion of it, in the shortest possible time, or at any rate sooner than would be the case if the fish lived only on natural food. It may become possible by artificial feeding to determine beforehand what weight the carp will reach within a certain given time. A second object of artificial feeding is to enable the stocking of a pond with a larger number of fish than it could otherwise support.

By artificial feeding the carp cultivator may derive extraordinary advantages, as it will, to a certain degree, make him independent of the nature of his ponds, make the yield of poor ponds equal to that of the best, so that he can stock them with any number of fish; of course making this proportionate to the size of the pond and to the quantity of water. Even if only introduced in one or two ponds, artificial feeding will prove advantageous; and the same applies to periodical feeding, say during the months of May, September, and October, when the quantity of natural food is smallest. In spite of all these advantages, however, it will be a problem whether—and, if so, by what method of feeding—the pond cultivator will be repaid for his trouble. We intend to discuss this problem at some length.

The first question will be whether a system of artificial feeding will pay; that is, whether the undoubted increase of weight attained thereby will compensate for the expense and labor connected with it, so as not only to cover the expense, but also to leave a considerable net revenue. In order to answer this question we must first endeavor to get a satisfactory answer to the questions: What food is to be used, and in what quantity? Before endeavoring to answer these questions from the present stand-point regarding the general principles of sustaining animal life, we will hear what old and experienced pond cultivators have to say on the subject. I consider their experience as very important and in many respects of practical use, even in our days. Their methods of preparing fish-food may at any rate give valuable hints how to preserve the food from spoiling, in case it is not eaten by the carp as soon as it is thrown into the pond.

That the pond cultivators of bygone times have employed artificial feeding is proved by their own statements on the subject; and that they found it advantageous appears from the fact that they often employed expensive articles of food. Even if such food was not as expensive in those days as it is now, it should be remembered that the price of carp was much lower. Von Reider, for instance, recommends the following method of feeding carp in fish-tanks: "Perforate both the bottom and sides of light kegs, fill them with ground malt, and throw them into the fish-tanks. Others take good, fat clay, broken into small pieces, mix it with the malt, and put this mixture in a keg, which is closed firmly. By pushing the keg about, the carp cause the malt and clay to ooze out through the holes, and thereby the water is rendered sweet and nourishing. Others mix malt and wheat flour, make this mixture into loaves, which are baked in an oven. Others again bake loaves of ground malt and clay, well kneaded together, and throw the broken loaves into the fish-tank. Others take fat clay, the solid excrements of sheep, malt, and a little salt, kneed all this into a dough, which is rolled out thin and scattered along the banks. Others take fat clay, mix it with honey and barley flour, kneed it well, and form it into balls, which are thrown to the fish. The clay should be mixed with sand, to aid the fish in digesting it."

Jokisch recommends the following fish-food: "The so-called fish-bread, which is baked in an oven or dried in the sun, should be made of such ingredients that if baked in summer it will keep in a dry place till winter. Potatoes, peas, lentils, beans, &c., are cooked until they are tolerably soft, and thereto are added bran, a little refuse from breweries or spoiled malt, and dark flour, which serves to give consistency to the whole. With this mixture some brewer's yeast, poor milk, or water is incorporated, and allowed to work it thoroughly, when it is formed into loaves. If these loaves are baked in an oven, they should be made tolerably large, while they must be small if they are to be dried in the sun, so as to prevent their molding or rotting, of which there is danger in water which is not running at all times. Such loaves are broken and thrown into the ponds in quantities to suit the number of fish, and after a few days they are devoured by the fish. In ponds which do not receive much natural food from the outside, artificial food will be very useful. Husks of beans and various kinds of grain, and particularly the carcasses of horses, will here render excellent service. It will always be found that wherever the refuse from breweries, distilleries, starch factories, &c., is emptied into ponds, the fish will be particularly fat and of excellent quality. Potatoes boiled and cut up also form an excellent article of food for carp."

Tscheiner says: "The fish will get fat if fed on a mixture of hemp, beans, peas, and the solid excrements of sheep. Rest also favors the fattening of carp, and they are, therefore, fattened outside the water in the following manner: They are wrapped in moss, which is constantly

kept moist, so tightly that they cannot stir, and if fed on the food described above they will grow fat in a very short time and acquire a most delicious flavor. Another means of fattening fish is to castrate them. This operation was first tried in England, not only on carp, but also on pike and other fish. It seems, however, that the great expectations entertained in regard to this method were not realized." *

Unfortunately, the above data do not contain the slightest hints as to the quantity of food, and also leave us entirely in the dark as to the results (in figures). They are, nevertheless, exceedingly valuable for making experiments, and because they show what articles of food were used successfully by former pond cultivators. In all probability it would pay even in our days to employ such food. We also learn that the food consisted principally of those products of the vegetable kingdom which contain a great deal of albumen. The articles of food described above were generally employed in small receptacles such as fish-tanks, and the only one among the older authors on the subject who states that they may with as much advantage be employed in ponds is Jokisch. It may be presumed, however, that the articles of food mentioned by the other writers may be used in ponds as well as in tanks. We will cite the following interesting example, which shows how profitable the artificial feeding of carp may be. The papers contained an account of a German by the name of Poppe, residing in California, who imported carp from Germany and placed them in a pond containing warm springs. The carp were fed on blood, thick milk, refuse from slaughter-houses, &c., and grew marvelously. When placed in the pond they measured 15 centimeters in length; after nine months they commenced to spawn, and after twelve months they measured 50 centimeters in length and weighed from 12 to 15 pounds.† Delius, who gives an account of Mr. Poppe's experiments, says: "These results seem almost incredible, but, by taking into account all the local conditions, we must grant that they are within the reach of possibility. It should be remembered that the water all the year round‡ had the most favorable temperature of 18° Réaumur [72½° F.], and that the development of the fish was not retarded by a single cool day. In one year the original weight of the carp had increased sixty or seventy fold. A young pig at its birth weighs about 6 pounds, and there are instances where the weight of such a pig was in twelve months increased to 400 pounds, which would show about the same ratio of increase as that of the carp referred to above." We regret that we are not informed as to the quantity of food which Mr. Poppe gave to his carp; but it may be presumed that this development was reached by employing food which contained a great deal of nitrogen, from which it may be inferred that the carp, in order to grow

* Tscheiner, p. 191.

† Delius, *Teichwirthschaft*, p. 28.

‡ The growth of the fish was, therefore, not interrupted during winter, and the twelve months are fully equal to two years under our conditions.

rapidly, should be fed on articles containing a great deal of nitrogen. After giving the above data, we shall now endeavor, proceeding by analogy, to ascertain, on the basis of the laws which regulate the feeding of various domestic animals, that proportion of nutritive substances which is most favorable to the development of carp, and the quantity in which the food should be administered.

The substances composing the various articles of food of the higher classes of animals are divided into those which contain nitrogen and those which are free from nitrogen. To the former belong the proteine or albuminous substances, to the latter the hydrates of carbon and fat. Vegetable food contains comparatively much less nitrogen than animal food. The most profitable method of feeding domestic animals is that which provides the quantity of nutritive matter which is best suited to the purpose these animals are to serve, and provides it in the proper proportion, *i. e.*, the right proportion between the digestible albuminous substances and the digestible hydrates of carbon, including fat. The substances containing nitrogen—in other words, the albuminous substances in the various changes which they undergo in the animal body—mainly serve to form flesh and fat, while those substances which contain but little nitrogen principally serve the purposes of respiration.

By comparing the different methods of feeding domestic animals, chiefly cattle, whose food belongs exclusively to the vegetable kingdom, and the different kinds of grass of good pasture-lands, in which the proportion of nutritive matter—*i. e.*, the proportion between the substances containing nitrogen and those which do not contain it, is as 1 to from 5 to 6—it has been ascertained that the most profitable proportion of nutritive substances is about 1 to 4 or 1 to 7. Professor Wolff says: "If the food contains less albumen than would correspond to the proportion 1 to from 6 to 7, a considerable portion is not properly digested and absorbed, and a part of the nutritive substances which do not contain nitrogen is passed with the excrements, without having been of any use to the body. If the proportion exceeds that of 1 to from 6 to 7, there is not sufficient albuminous matter to attain the desired production quickly and safely, it progresses slowly and without energy, so that in the end the profits are very small, even if the food has been very cheap. A proportion like that of 1 to 4 is never needed in feeding domestic animals, as it would tend to further the disintegration of matter in the body and cause losses in the end. But if the absolute quantities of the nutritive substances containing nitrogen and of those which are free from nitrogen are sufficiently large and do not exceed the proportion given above as the most suitable, all reasonable requirements have been met. No losses need then be feared by a relaxation of the digestive organs or too great a disintegration of matter; nor will there ever be a lack of material to favor quick and ample production. The most suitable proportion for purposes of production will, therefore, be somewhere between 1 to 4 and 1 to 7; although it may be

laid down as a general rule that, within these limits the total quantity of effective nutritive matter being the same, production will increase as the proportion becomes smaller; but whether in the end it will yield greater profits will have to be decided according to local circumstances."*

The proportion between albumen and hydrates of carbon will be particularly influenced by the circumstance that in their food the animals should receive the quantity of hydrates of carbon which they absolutely need for purposes of respiration. From experiments made by Müller it appears that this quantity varies very much in the different animals. Per 100 pounds weight of the body the tench exhales 12 grams carbon =1; the frog, 43.5=3.5; man, 146.0=12; the pigeon, 1370.=114. It appears from these figures that fish—in this case the tench, which greatly resembles the carp in the quantity and quality of food it needs—use for the processes of life, more particularly of respiration, a very small portion of hydrates of carbon as compared with warm-blooded animals. These figures, therefore, may serve as a guide in finding the most suitable proportion of nutritive substances for fish. But as no experiments have been made to test the matter, and as at any rate nothing has been published on the subject, all that can be done is to draw conclusions from analogy and compare therewith the experiments in feeding warm-blooded animals. The exhalation of carbon holds a certain relation to the absorption of oxygen. The more oxygen is absorbed the more hydrates of carbon will be destroyed, the greater warmth is generated in the body, and the more carbonic acid is exhaled. But as fish have no warmth of their own, but always have the temperature of the water in which they live, they need only a small quantity of hydrates of carbon to keep up life, and the result of Mr. Müller's experiments is proved true.

Although it is impossible to find out from these experiments what is the proportion between the quantities of carbon inhaled and exhaled, it is safe to assume that the greater the quantity consumed in the respiratory process, all the more hydrates of carbon will have to be introduced into the body with the food, and *vice versa*. Baussingault's observations throw some light on the proportion between the quantity of carbon in the food and that consumed by the respiratory process in domestic animals. It appears that the milch-cow and the horse exhale 60 per cent, the hog 70 per cent, and the pigeon 80 per cent of the carbon absorbed with the food. These data, however, do not yet answer our purposes, and we have to look further. Experiments made at Wende with full-grown sheep have shown that these animals, while receiving 481.3 grams carbon with their food, exhaled 222.5 grams (*i. e.*, 60 per cent) per 100 pounds of live weight in twenty-four hours.† The

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* Prof. E. Wolff, *Fütterungslehre*, 1874, p. 147.

† Prof. E. Wolff, *Fütterung der landwirthschaftlichen Nutzthiere*, 1874, p. 35.

food used in these experiments was hay of medium quality, and the proportion of nutritive substances was probably the following:

$$\text{Nh} : \text{Nfr} = 1 : 7.$$

As was stated above, the tench exhaled per 100 pounds weight in twenty-four hours, 12 grams carbon, while the sheep exhaled 222.5 grams, therefore 18.5 times as much. We now know the quantity of carbon consumed and exhaled by sheep per 100 pounds live weight, and when a certain kind of food is employed; we also know the quantity of carbon exhaled by an equal weight of tench, and we can therefrom easily calculate the quantity of carbon consumed by tench. We are, therefore, enabled, since we have three known quantities, to find the fourth one by the following proportion:

$$222.5 \text{ grams} : 12 \text{ grams} = 7 \text{ Nfr.} : x \text{ Nfr.}$$

$$x = \frac{12 \times 7}{222.5} = 0.38.$$

We get the same result if we say that the proportion between the absorption of carbon with the food of sheep and the absorption of carbon by the tench—which is found by the following proportion: $222.5 : 12 = 481.3 : x$, *i. e.*, $x = 25.9$—is as follows:

$$481.3 : 25.9 = 7 : x, \text{ whence } x = 0.38.$$

The proportion of nutritive substances in food, therefore is, for sheep, Nh : Nfr = 1 : 7; carp = 1 : 0.38.

As the absorption of nutritive substances in the different kinds of hay varies from 1 : 5.1 to 1 : 10.6, and as we do not know what kind of hay was used in the experiments made at Wende, the proportion of nutritive substances in the food of the carp will probably vary between 0.27 and 0.57. It can hardly be supposed, however, that the hay used in the experiments referred to was anything but hay of a medium quality, as first-class hay is but rarely met with in that locality. The difference will, therefore, be only between 1 : 7 and 1 : 8, and for the carp between 0.38 and 0.43.

Although this whole calculation is somewhat bold, and absolute correctness cannot be claimed for its results, it is probable that these are at any rate approximately correct. This proportion of nutritive substances is very close; but we will have to acknowledge its approximate correctness, if we take into consideration the following facts:

1. For generating and maintaining the normal degree of heat in the body of warm-blooded animals (with man, 37° Centigrade [$98\frac{3}{5}$° F.]) a certain quantity of carbon, and therefore of hydrates of carbon, is needed, which, in connection with the oxygen inhaled, causes the destruction (by a burning process) of fat in the animal body, by which heat is generated. Fish have no heat of their own, therefore need no

carbon for generating and maintaining heat, and require only a small quantity of carbon which is necessary for burning the substances which decay through the process of life.

2. Fish have an advantage over land animals in needing less force for their movements. While land animals need a considerable exertion of the muscles even when they stand perfectly still; fish can swim about, or rest at the bottom, without any special exertion; and even their movements in any direction whatever require less exertion than the movements of land animals, which have to propel their bodies by lifting the feet. The water moreover offers but little resistance to the movements of fish. This is easily explained if we remember what heavy pieces of lumber a man can propel in the water with comparatively little exertion, while he would not be able to move them on land. If swimming tires a man more than walking, this is not caused by the greater exertion required by the movement in the water, but because those muscles which are principally brought into play are those which otherwise are not accustomed to rapid and long-continued movements. Writing, for example, does not in itself require any great exertion, and still a person not accustomed to it will get more tired by an hour's writing than by the same time spent in manual labor. As great exertions of the muscles accelerate the disintegration of matter in the animal body and increase it to a degree which becomes injurious, this must be neutralized by introducing more food into the body; while, on the other hand, a steady and ample supply of suitable food will cause the body to grow more rapidly.* The small quantity of hydrates of carbon needed in the food is therefore easily explained by the fact that the exertion is less; for in strong exertion the loss is occasioned not so much by the wear and tear of the various organs of the body and the destruction of albumen, as by the increased burning of hydrates of carbon, in consequence of which a greater quantity of oxygen is absorbed by the process of respiration, and more heat is not only generated, but also exhaled.†

3. The small quantity of oxygen absorbed also necessitates a comparatively small absorption of hydrates of carbon.

4. The component parts of the carp, according to Dr. König, of Munster, are the following: 76.97 per cent water, 20.61 per cent substances containing nitrogen, 1.09 per cent fat, 0 per cent substances free from nitrogen, 1.33 per cent ashes.

According to the above figures—the quantity of substances free from nitrogen being=0—food which contains much nitrogen appears to be the most suitable food for carp.

Professor Wolff's analysis of the carp shows different results, viz.: 79.8 per cent water, 13.6 per cent albumen, 1.1 per cent fat, 4.5 per cent extractives free from nitrogen, 1 per cent ashes.

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* Wolff, *Fütterungslehre*, p. 27.

† Wolff, *Fütterungslehre*, p. 64.

I am unable to decide which of these two naturalists is right, but I deem it proper to give both sets of figures.

From the above it appears that fish, compared with warm-blooded animals, need a small quantity of carbon, and consequently fewer hydrates of carbon in their food; and the approximate proportion of nutritive substances, as given by us above becomes still more probable, even if it is not confirmed in all its details. It also appears that, with an equal quantity of food, fish will grow more rapidly than land animals, because in the same quantity of food they receive a much greater portion of albuminous matter which is changed to flesh and blood. This increase of weight in fish, which is sometimes marvelous, as the example of Mr. Poppe's carp in California shows, proves that with an increased quantity of albumen, introduced into the body, there will be a corresponding increase of flesh and fat.* The growth of the carp is also promoted by the extraordinary digestive power of which these fish are possessed, and which among the rest is shown by the fact that they appropriate from the excrements of animals nutritive substances which these animals were not able to digest.

We will now compare with the most favorable proportion of nutritive substances, as calculated above, the proportion of these substances as existing in the food which nature provides for them in the ponds. Besides vegetable matter and various nutritive substances dissolved in the water, this food comprises worms, maggots, snails, beetles, and other insects. Beetles and insects generally, when dried, contain on an average 95 per cent of nitrogenous substances. As regards the nutritive matter contained in worms, maggots, and snails, no observations have been made. Delius† is of opinion that the quantity of proteine contained in them is like that of the silk-worm, viz., 15 per cent; I think, however, that this percentage is too low as far as snails and maggots are concerned, which latter are generated in flesh and blood; for they are formed from strongly albuminous substances, and therefore probably contain a good deal of nitrogen. It is well-known that snails form a very nutritious article of food, and probably contain much proteine. However this may be—for we cannot entertain mere suppositions—we will take, as a tolerably safe basis, beetles and other insects and their larvæ (the former are formed from the material of the latter, and their quantity of nitrogen will probably not vary much), which compose the larger portion of the natural food of the carp.

The circumstance that the percentage of proteine (95) given above applies to dried beetles and insects, while carp always eat them alive, will not make any difference in our present calculation, as the proportion of nutritive substances remains the same, no matter whether the food is dried or fresh.

According to Prof. E. Wolff, the proportion of nutritive substances

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* Wolff, *Fütterungslehre*, p. 423.

†Delius, *Teichwirthschaft*.

in cock-chafers—which in years when these beetles are plentiful doubtless in great part form the food of the carp in ponds which are surrounded by trees and shrubs whence the wind casts them into the water—is Nh : Nfr = 1 : 0.6. We are justified in supposing that the proportion of nutritive substances in other beetles and insects, as well as in their larvæ, is very similar. Our calculations showed the proportion to be 1 : 0.38, and 0.43, and 0.57, respectively, so that the difference between the two proportions is not very great, especially if we take into consideration that the proportion of nutritive substances, in all probability, varies a little in the different insects. We shall, therefore, not be far from the truth if we say that the most favorable proportion of nutritive substances in carp-food is Nh : Nfr = 1 : 0.5 (or 0.6), and that consequently food containing a good deal of nitrogen is the best and most profitable for carp. Before entering upon a further examination of the question which is the most suitable quantity of food, we will give, in tabulated form, the various articles used as carp-food, showing the percentage of nutritive substances contained in each, following in this the tables prepared by Prof. E. Wolff:

In 100 pounds of food.	Per cent of—				
	Water.	Digestible substances.			Proportion of nutritive substances. Nh.=1.
		Albumen.	Hydrates of carbon.	Fat.	
Blood, fresh	80.0	19.1		0.1	0.1
Blood, dried	12.0	54.1	2.6	0.5	0.1
Horse-flesh, lean	76.3	21.6		1.1	0.1
Fish guano	12.6	44.1		1.6	0.1
Curds	52.5	38.0		7.7	0.2
Gluten, dry		68.9	16.0	1.5	0.3
Meat, dried and ground fine	11.5	69.2		11.2	0.4
Heart, lungs, liver, and brains of oxen		16.3	0.3	7.3	0.5
Worms, maggots, beetles, other insects, and their larvæ.					0.5 to 0.6
Cock-chafers, fresh	70.4	13.0		3.1	0.6
Cock-chafers, dried	13.5	38.0		9.1	0.6
Pumpkin-seed cake	12.0	50.0	9.7	10.5	0.7
Beef	70.0	18.3		15.8	0.9
Linseed flour, from which the oil has been extracted	9.7	27.8	33.9	2.1	1.4
Hemp-seed cake	9.9	20.9	17.4	5.2	1.5
Poppy-seed cake	11.5	26.8	35.4	7.4	1.7
Rape-seed cake	11.3	25.3	23.8	7.7	1.7
Rape flour, from which the oil has been extracted	8.5	26.5	26.2	2.5	1.9
Skimmed milk	90.0	3.5	5.0	0.7	1.9
Linseed cake	12.2	24.8	27.5	8.9	2.0
Vetches	14.3	24.8	48.2	2.5	2.2
Field beans	14.5	23.0	50.2	1.4	2.3
Malt germs	10.1	14.4	45.0	1.7	2.5
Lentils	14.5	21.4	51.2	2.2	2.6
Buttermilk	90.1	3.0	5.4	1.0	2.6
Peas	14.3	20.2	54.4	1.7	2.9
Pea flour	11.4	20.9	55.4	2.8	3.0
Refuse from breweries	76.6	3.0	18.8	0.8	3.4
Refuse from distilleries	91.0	1.7	5.4	0.3	3.5
Red clover, before it has bloomed	83.0	2.3	7.4	0.5	3.8
Wheat bran	12.9	12.6	42.7	2.6	3.9
Rye husks	70.0	5.2	18.1	1.2	4.1
Refuse from potatoes used in distilling	91.9	1.5	5.8	0.2	4.2
Cow's milk	87.5	3.2	2.0	3.6	4.4
Rye bran	12.5	12.2	46.2	3.6	4.5
Gluten, refuse from starch factories	70.0	6.4	24.5	0.5	5.0
Wheat husks, from starch factories	71.0	3.7	15.1	1.8	5.3
Red clover in full bloom	80.4	1.7	8.7	0.4	5.7

In 100 pounds of food.	Water.	Per cent. of— Digestible substances. Albumen.	Hydrates of carbon.	Fat.	Proportion of nutritive substances. Nh.=1.
Grains of wheat	14.4	11.7	64.3	1.2	5.8
Grains of oats	14.3	9.0	43.3	4.7	6.1
Whey	92.6	11.0	5.1	0.6	6.6
Grains of rye	14.3	9.9	65.4	1.6	7.0
Turnips	91.5	0.9	6.8	0.1	7.6
Grains of barley	14.3	8.0	59.9	1.7	7.9
Grains of corn (maize)	14.4	8.4	60.6	4.8	8.6
Malt, dry	7.5	7.5	67.2	1.8	9.4
Potatoes	70.5	2.1	21.8	0.2	10.6
Potato fiber, refuse from starch factories	86.0	0.8	13.7	0.1	17.4
Excrements of cattle	71.0	0.5	12.3	0.2	*30.5

*From experiments made on the farm of Mr. J. Schwarz, at Hofgarden, in Sweden, with feeding milch-cows on horse-dung, it appears that, as to their nutritive qualities, 300 pounds of horse-dung are equal to 100 pounds of straw. One hundred pounds of straw contain, on an average, the following quantities of digestible nutritive substances: about 1.5 per cent albumen, 36.9 per cent hydrates of carbon, and 0.5 per cent fat, and the average proportion of nutritive substances is 30.5 per cent, therefore the same in 300 pounds of horse-dung, and in 100 pounds of excrements of cattle. (See the agricultural journal *Der Landwirth*, 1875, No. 71.)

If the food of the fish is to be thrown into the water, the question will have to be considered whether in case it has to lie in the water for any length of time it will not lose some of its nutritive qualities. Wherever there is any danger of this it will be necessary either to substitute food which will resist the influence of the water or to envelop the original food in it. Mixing the food with clay will also have a good effect. Cooked food, *e. g.*, the various kinds of grains, peas, beans, potatoes, &c., is in that condition less exposed to the influence of the water than when raw. The manner in which pond cultivators in former times prepared their food shows that they had the same experience.

The spoiling of food in the water and the precautionary measures referred to above may be avoided by giving the food to the fish regularly at stated times and throwing it all into the water at one and the same place not far from the bank, so that one may observe how much of it is eaten. If the fish have once become accustomed to a regular feeding time and place they will always gather there at that time, and it is said that they will even follow the sound of a bell. It will soon be seen how much or how little of the food is eaten, and the quantity of food can be regulated accordingly. It will require a little experimenting to find the right quantity, and all we aim at here is to give a theoretical basis for such experiments. The kind of food, and the proportion in which different kinds of food should be mixed, is determined by the proportion of nutrititive substances most favorable for carp, as given above, according to which concentrated or condensed food is the best, as in other kinds of food there is a waste of hydrates of carbon.

The most suitable articles of food, therefore, are blood, horse-flesh, fish guano, curds, meat dried and ground fine, refuse from slaughter-houses, &c. All these, however, require to be mixed with other articles of food containing less nitrogen, so as to restore the proper proportion

of nutrititive substances. On the whole the food for carp will have to be mixed very much on the same principles as that for cattle and other domestic animals.

Two other questions will have to be answered, viz.: (1) How much food is to be given? and (2) How is this to be calculated? As there are no data on the subject, it will be difficult to lay down exact rules as to the quantity of the food. It will be correct to presume that at least approximately the same principles will have to serve as a basis as those prevailing in the feeding of cattle, and we shall, therefore, be enabled to fix a standard which will come as near the true one as possible.

As a sufficient supply of food causes the growth, and consequent increase of weight, to be very rapid both in the carp and the hog, and as the carp, like the hog, is an omnivorous animal, we will take the needs of the hog as a basis for determining the quantity of food required by the carp. To produce the greatest possible quantity of flesh and fat, say 1,000 pounds live weight, a hog needs on an average about 4 pounds of albuminous matter per day. Two pounds of hydrates of carbon and fat, respectively, will correspond to this on the basis of nutritive substances needed for carp-food, as calculated above. As 100 pounds of worms, beetles, and other insects, when fresh, contain 30 per cent dry substance (comprising 13 per cent albuminous matter and 3.1 per cent fat, the latter being for purposes of respiration equal to 8 pounds of hydrates of carbon), and as the proportion of albumen to hydrates of carbon in carp-food is as 2 to 1, we may lay it down as a rule that 1,000 pounds of live carp will require the following quantity of food: 9 pounds of dry substance, 4 pounds of albumen, and 2 pounds of hydrates of carbon, which in all probability the carp will find in a good pond. This would be the standard quantity of carp-food, if nature did not supply any food besides that which is thrown into the pond. This standard may, therefore, be used only in cases where a pond is to be stocked with a larger number of fish than its natural conditions of food allow.

If artificial feeding is simply to supplement the natural food, the quantity of aritficial food will have to be determined by the quantity of the former contained in the pond; the proportion between dry substance, albumen, and hydrates of carbon should, however, remain the same as that given above. On this basis a pond which according to its quantity of natural food could sustain 2,000 two years' fish, weighing on an average a half pound each, would, if stocked with 4,000 fish, *i. e.*, with an additional 2,000, have to receive the following quantity of food per day: 9 pounds of dry substance, 4 pounds of albumen, and 2 pounds of hydrates of carbon, since the additional weight would be 1,000 pounds. This quantity of food will have to be gradually increased with the corresponding increase of weight of the fish.

If natural food is found in the pond, the additional 2,000 fish weighing one-half pound each, would, in a summer, even in medium ponds,

increase to at least $1\frac{1}{4}$ pounds apiece, making an increase of three-quarters pound per fish; the total increase for the 2,000 would therefore be 1,500 pounds, which, counting the pound at 50 pfennige [$12\frac{1}{2}$ cents], would represent the sum of 750 marks [$178.50]. It should be remembered that if an additional number of fish, like the one referred to above, is placed in a pond, regard should be had not only to a proper supply of food, but also to an ample area of water. We would require, for a period of one hundred and eighty days—April to September, inclusive—for the 2,000 original and the 2,000 additional fish (all in one pond), which supplies food for only 2,000, the following quantity of food: $180 \times 4 = 720$ pounds albumen and 360 pounds of hydrates of carbon. Add to this one-half more, in consequence of the increase of the rations corresponding to the growth of the fish, and the total quantity of albumen to be supplied would be 1,080 pounds. To supply this we would need, say, of meat dried and ground fine, 15.6 hundred-weights, at 15 marks [$3.75], making the total outlay 234 marks [$58.50]. Subtracting this amount from the gross income, given above, we would get a net profit of 516 marks [$120].

It appears from these figures that even a comparatively expensive food will pay in the end, which result, in part at least, is brought about by the fact that this food possesses, at any rate, approximately, the correct proportion of nutritive substances. In order to provide the desired quantity of hydrates of carbon it will of course be necessary to mix with the ground meal some other food containing less nitrogen; this will rather diminish than increase the price of the food. The addition of some article of food containing less nitrogen will be all the more necessary—if the ground meat, as in the example given above, is to be used almost exclusively—because otherwise the fish would not get the needed quantity of alkali, of which ground meat contains but little. As regards supplying the necessary quantity of hydrates of carbon, it may not always be required to add anything to the ground meat, as the proportion of hydrates of carbon may vary from 1 to from 0.4 to 0.5. For this very reason I have selected ground meat as an illustration, because the calculation will be simplified; also because it is one of the most expensive articles of food, but can be easily furnished at any time and in any desired quantity, which, of course, is not the case with articles like blood and refuse from slaughter-houses, excellent as they may otherwise be. It also applies here what Professor Wolff says in his *Rationelle Fütterung der landwirthschaftlichen Nutzthiere*, 1814 (Rational method of feeding domestic animals), p. 191, "that the rules laid down for feeding should be followed only in their general outline, and that it is not necessary to have everything agree down to the least fraction."

Next to ground meat, fish guano may be recommended for feeding carp, because it possesses excellent nutritive qualities, and can easily be obtained. In order to obtain the quantity of albumen in animal

excrements needed for our example, we would—presuming with Delius that on an average they contain 3 per cent of albumen—need not less than 3,600 pounds, which at the lowest rate (60 pfennige [15 cents] per 100 pounds), would cost 216 marks [$54]. In using this food there would consequently be some saving, but it is doubtful whether the same favorable results will be obtained as with ground meat, because the proportion of nutritive substances is not so favorable, and because the fish would need an enormous quantity of it. It may, however, be assumed with absolute certainty, that even if fish guano is used as food, the increase of weight will be greater than if the 2,000 fish in one pond are confined to the natural food supplied by it. For in this case the quantity of food will decrease as autumn approaches, while by employing artificial food the daily quantity of food needed for the fish is regularly supplied throughout the entire period of their growth. The saving in the use of excrements is only a seeming one, as owing to their volume the transportation will involve considerable expense. To convey the 3,600 pounds to the pond would require twenty trips by cart, which, including loading and unloading, would come to 3 marks [75 cents] a trip. It must also be questioned whether the percentage of albumen in excrements, as given by Delius, is absolutely correct, and I think the circumstance has been lost sight of that only their digestible parts are of any value. Counting the digestible quantity of albumen—on the basis of the table given above—at 0.5 per cent (which, as we should state, refers only to the excrements of horses, which of all excrements contains the largest quantity of indigested matter) we would need not less than 211,600 pounds; but even supposing that the digestive power of the carp is twice as great as that of cattle, and consequently instead of 0.5 that 1 per cent was digested, we would still need the enormous quantity of 105,800 pounds to equalize the nutritive value of 1,560 pounds of ground meat. It will easily be seen that even if these excrements were otherwise of no value whatever, this method of feeding would prove exceedingly unprofitable.

Animal excrements may be used as an occasional addition to the food contained in a pond, and will, if so used, always yield astonishingly favorable results, probably because the natural food contained in the pond will be suitably supplemented thereby; but to use them as an exclusive article of food can hardly be recommended. There will, however, be many opportunities of using other concentrated articles of food, *e. g.*, blood, horse-flesh, refuse from slaughter-houses, &c., at comparatively much cheaper prices than ground meat, and with the same favorable results, either if used by itself or in connection with ground meat.

Another question remains to be answered: Would it be advisable, even in ponds having their normal stock of fish, to add artificial to the natural food during all summer, or at least during part of it? After all we have said, this question will have to be answered in the affirmative. Another reason why this may be recommended, is the fact that carp

will fully repay by their increased growth any addition, if ever so slight, to their natural food. This is fully proved by the results obtained in ponds which have been sowed, or in ponds which receive much nutritive matter with their water supply, or in which cattle occasionally deposit their excrements, if compared with ponds where none of these conditions exist. Under favorable circumstances, such as those mentioned, it is no rare case that carp weighing ½ pound reach a marketable weight in one summer. I can mention such cases from my own experience, and from that of entirely trustworthy persons. Thus Delius mentions, from his own observations, that he has known carp to grow from 132 grams to 2 pounds (960 grams) in a single summer; and adds that he has been informed of still more astonishing results by reliable authorities. It may, therefore, be recommended for all ponds which do not have a sufficient quantity of food, or which are not in a natural way supplied with such food, to add some artificial food every day, or at certain stated periods; and in any pond, where it can be done, artificial food should be introduced from September, the time when the natural food begins to decrease, and when the weather grows cooler, and when the feeding process is to serve likewise for supplying that degree of heat which is necessary for the growth of the fish. Heat, as is well known, is a most important element in the growth of fish, and the results both of natural and artificial food should always be judged from the stand-point of an equal temperature.

The experiences gathered from the Wittingau pond farm show that the increase in the weight of carp was 10 per cent in May, 30 in June, 35 in July, 20 in August, and 5 in September. The greatest increase, therefore, was in July and the smallest in September. We are, therefore, justified in supposing that in July nature supplies the normal quantity of food needed by fish, leaving out of the calculation the element of heat and the varying quality of the ponds. If we intend to keep up the same supply of food during all summer, we would have to add in May 25 per cent of artificial food, in June 5, in August 15, and in September 30 per cent.

Even supposing that, owing to the great extent of the pond farm, it is impossible to introduce a regular system of feeding in all the ponds, throughout the entire period of growth, for the simple reason that the necessary labor cannot be obtained, it should on no account be omitted in September; for, as we have seen, this month furnishes the least food for the fish, while this is the very time when, in stock ponds, the fish should be fattened for the market. Let us, as an example, see what will be the results if ground meat is fed to the fish from the beginning of September till the middle of October, *i. e.*, forty-five days. We will suppose that a pond having an area of 10 hectares has been stocked with 1,200 carp, weighing each 1¼ pounds, which by the end of August have reached a weight of 2 pounds apiece, whose entire original weight has therefore increased from 1,250 to 2,400 pounds. The increase would

be 1,150 pounds, and for the month of July 35 per cent, *i. e.*, 402.5 pounds. We desire to obtain the same increase for the period from the beginning of September till the end of October—forty-five days—*i. e.*, for September 402, for October 201; in all, 603 pounds. Five per cent of this desired increase—in round figures, 30 pounds—is obtained by means of natural food, and the remainder, 573 pounds, will have to be produced by artificial food. We know that 1 pound of ground meat produces an increase in the weight of fish of almost 1 pound. In order, therefore, to supply the required quantity of food during these forty-five days, so as to make the supply equal to that of July, we need 573 pounds of ground meat, which, at the rate of 15 marks [$3.75] per 100 pounds, would involve an outlay of 86 marks [$21.50]. By using this quantity of ground meat we are able to produce 573 pounds of fish flesh, which, at the rate of 50 pfennige [12½ cents] a pound, would realize the sum of 286.50 marks [$71.53], leaving a net profit of 200.50 marks [$50.12½], from which sum there should be deducted the comparatively small amount for conveying the food to the pond. We are, therefore, fully convinced that the use of artificial food for carp, even if there is used still more expensive food than the one given in our example, will insure quite a handsome profit; for although all the above calculations may not be correct in every little particular, they are certainly approximately correct.

As regards the other articles of food mentioned in the table given above, those must always be considered the most profitable whose proportion of nutritive substances comes nearest to the standard proportion. The proper proportion can in all cases easily be restored by adding a suitable quantity of food containing less nitrogen. Even in employing food containing more nitrogen the pond cultivator will still realize some profits, but he will find it impossible to restore the proper proportion of nutritive substances. This, however, would hinder the carp from deriving the greatest possible benefit from their food; and, with an equal (and often greater) expense, it will be found impossible to obtain the same favorable results as with a food or mixture of different articles of food which, not only as to quantity but also as to the proportion of its nutritive substances, comes nearer to the standard proportion. Food containing but little nitrogen, if used exclusively, will always prove injurious. An example will serve to make this clear. If rape-cakes are used the expense for 1,080 pounds of albumen, *i. e.*, for 4,265 pounds of rape-cake, at 6 marks [$1.50] per 100 pounds, would be 256 marks, 8 pfennige [$64.02]. The difference in the price of this food, which contains much nitrogen, will not be very great, but by the necessary addition of some article of food containing still more nitrogen and less hydrates of carbon, *e. g.*, blood, the cost may be increased to about 300 marks [$75]. Peas, even at their lowest market price, will be too expensive. The necessary quantity of albumen is contained in 5,400 pounds of peas, at 8 marks [$2] per 100 pounds, and this would make the outlay 452 marks [$113]; and, as with rape-cake, some other food would have to be added, reducing the net profits to a minimum.

If we take food containing but little nitrogen, *e. g.*, dry malt, we would need 14,400 pounds, at 8 marks per 100 pounds=1,152 marks [$288]; of potatoes we would need 51,400 pounds, at 2 marks [50 cents] per 100 pounds=1,028 marks [$275], and at 3 marks [75 cents] per 100 pounds=1,542 marks [$385.50]. A mere glance at these figures will show that there will be an absolute loss. The expense of mixing with a nitrogenous food some other food containing less nitrogen will be a little higher than if a single article of food is employed whose proportion of nutritive substances is very near the standard. If, for instance, we use fish guano, it will be absolutely necessary to mix with it some other food containing less nitrogen. We would get nearest to the quantity (1,080 pounds albumen) and the standard proportion of nutritive substances by mixing the following:

2,360 pounds fish guano, at 10 marks [$2.50] per 100 pounds=236 marks [$59].
2,000 pounds potatoes, at 2 marks [50 cents] per 100 pounds= 40 marks [$10].

276 marks [$69].

This would still yield a good profit, even if we count in some additional expense for cooking the potatoes, but it will never yield the same profit as ground meat used by itself. The same results will, to some extent, make themselves felt in cases where artificial food is employed in addition to the natural food.

It may, therefore, be laid down as a rule that, if artificial food is to be used exclusively, only those articles of food should be employed whose proportion of nutritive substances comes nearest to the standard, or which contain a large quantity of nitrogen. The same rule applies if artificial food is used only to supplement the natural food (as a deviation from this rule, though not of such serious consequences as in the first case, will nevertheless prove injurious); and food containing little nitrogen should only be used to restore the standard proportion of nutritive substances, if the principal food is blood, horse-flesh, fish guano, curds, &c. In the table showing the various articles of carp-food, I have also given fresh red clover; and I have done so because it is my idea that if there is a clover field near the pond, clover may be used in small quantities mixed with other food. If used in large quantities, however, or by itself, it would not be found profitable, for, to return to our example, to obtain 1,080 pounds of albumen would require 47,000 and 59,300 pounds of clover, respectively, which, at 2 marks [50 cents] per 100 pounds, would cause an outlay of not less than 940 marks [$235] and 1,186 marks [$296.50], respectively.

In using this food we would, moreover, have to take into consideration the fact—which applies to all articles of food which have to be given in great masses, especially to the excrements of animals—that the dry substance does not in the least come up to the proper standard of food, and that such enormous quantities would have to be used as to make it a matter of impossibility for the carp to consume them, simply to

obtain the small quantity of nutritive matter which they possess. Although it may, for various reasons, be found difficult to adopt a systematic method of feeding, a chance to supply the carp with food at no extra expense should never be allowed to pass by.

In many parts of our country the ponds are on all sides surrounded by pasture-lands, where the cattle drop their excrements, which soon dry in the sun and become the habitation of worms, maggots, &c. Without incurring any special expense these excrements may be gathered by the person in charge of the ponds, and either be kept till the months of September and October or be thrown into the ponds at once. This need not even be done every day, as one cart-load of these execrements per hectare, thrown into the pond once a week, will be accompanied by beneficial results. Owing to the maggots contained in the excrements they will prove an excellent article of food.

If there are distilleries near, good results may be obtained by throwing into the pond, every week, a quantity of fresh potato refuse from the distillery. Thus, we have been informed that by throwing 60 liters of such refuse into a pond having an area of 500 square meters every week from April 10th to November 9th, 104 carp, weighing originally one-half to 1 pound apiece, reached a weight of 2¾ to 3¼ pounds.*

If a cow or ox dies and cannot be used as human food, it may be made to do good service either by feeding it direct to the fish or by using it for generating maggots. This may be done in the following manner: (1) By simply placing large pieces of meat on poles rammed in the bottom of the pond. Without any further aid maggots will form in the meat and fall into the water; or, as birds of prey and other animals will often get the lion's share, it is better still (2) to use wooden boxes which have a lid and a perforated bottom, and rest on four slanting poles, or legs, so that they can be placed in the water, the legs touching the bottom. A carcass or a piece of meat is placed in this box, the flies crawl into it and deposit their eggs, and the maggots fall into the water†; (3) it will also answer the purpose simply to throw a carcass, or pieces of one, into the pond, so that the water covers it; and maggots and water insects will soon be generated in large numbers; (4) if it is intended to carry on the generation of maggots on a large scale, pits 60 to 70 centimeters deep and broad, and of any desired length, are dug in some sunny place near the ponds, which, to add to their security, may be paved and their sides lined with bricks or stones. At the bottom of these pits is placed a layer of rye straw cut fine, to the height of 15 to 20 centimeters, on the top of this a layer, 5 to 8 centimeters thick, of fresh dry horse dung, containing a good deal of straw; these two layers are covered with a layer of sifted earth, 15 meters thick, on which to the height of about 9 centimeters are thrown the blood of horses, oxen, or other animals, entrails, meat, decayed roots and vege-

*_Deutsche Fischerei-Zeitung_, 1878, No. 8.

†J. Wirth, _Zeitschrift des Deutschen Fischerei-Vereins_, 1871, VII, 48.

tables, kitchen refuse, dead animals, yeast, &c. The whole is covered with a thin layer of straw cut fine and some earth, and the pits are in rainy weather covered with boards.

All through the summer, but especially on warm, sunny days, a large number of flies of the species *Sarcophaga*, *Musca*, *Stomosis*, and others, attracted by the odor of the decaying matter, visit these pits to deposit their eggs, from which are developed quickly-growing larvæ, which, according to the state of the weather, may reach their full development in eight to fourteen days. After that period they change to tube-shaped cocoons, from which, after fourteen days, flies emerge to engage immediately in the propagation of their species. The gigantic scale on which these flies increase may be judged from the fact that the females of some species lay as many as 200,000 eggs, which, in about twenty-four hours, are transformed into maggots, the entire transformation from the egg to the fully-developed insect occupying only twenty-nine days. Only those larvæ which are developed late in autumn live through the winter as cocoons. The maggot-pit will also produce eggs, larvæ, and cocoons of other insects. The maggots, with the rest of the contents of the pit, are dug up with spades and thrown into the water. Such pits should be far from human habitations, and at some little distance from the ponds, on account of their nauseous and unhealthy effluvia.*

Before closing this chapter on the feeding of the carp I would strongly recommend to make experiments in feeding, and give my views as to the manner in which this should be done. Unfortunately, I had to give up pond culture before I was enabled to carry out this idea which I had cherished for a long time. The difficulty in these experiments is caused mainly by the circumstance that carp cannot be kept in a stable like horses or cattle, and that consequently they cannot be prevented from taking other food than that which is given to them. Experiments made in tanks of wood or stone, filled with pure water, would, on the other hand, lead to erroneous results, as the increase of growth gained by using a certain article of food would be neutralized by the stay in cold water and by other unnatural conditions. At the time when I conceived the idea of making such experiments, Mr. Horak was kind enough to write to me and suggest various ways of meeting the principal difficulties. He says: "It will be best to make comparative experiments, viz., to construct 6 to 10 ponds of the same size, all having the same soil, and stocked with the same number of fish. Each of these ponds should be supplied with a different kind of food, and the result should be carefully noted. One pond should be left to nature, and no artificial food should be introduced into it. Each pond should have its separate ditches for supplying and carrying off the water. The results of the fisheries would be the results of the different methods of feeding." To this I would add that it will be advisable to choose for these ponds a soil containing as little fish-food as possible.

* Baldamus, *Handbuch der Federviehzucht.*

Everything which is apt to influence the results of the feeding should be considered and carefully noted down. A certain stated weight of food should be given every day, and the quantities of albumen, dry substance, hydrates of carbon, and fat should be accurately ascertained. Observations of the temperature of the water should be taken daily at certain stated hours, in the morning, at noon, and in the evening, both near the banks and in the deep places. Similar observations should be taken of the temperature of the atmosphere, so as to get the maximum and minimum temperature. Careful notes should be taken of the rainfall, the wind, and weather, drawing the averages for the entire feeding period, *i. e.*, the whole summer or portions of it. These experiments should extend over a period of several years, so that the results of different years may be compared. The main object, viz., to ascertain the effect of different articles of food under the same conditions, will be attained in one year, and this will suffice for fixing a standard of feeding, which will stand the test of practice, although in the course of years it may become necessary to modify this standard in some particulars.

All the various articles of fish-food should be used as food, both those containing much nitrogen and those which contain but little; and the matter of expense should never prevent the use of any article of food, for the question to be answered is this: Are these different articles of food cheap or expensive as compared with the results attained? And this question cannot be answered until the experiments have been completed. It should not be omitted to supply one pond only with such articles of food as nature furnishes for the carp, *e. g.*, beetles, worms, snails, insects of every kind, &c., which should be gathered from ponds containing a superabundance of such food. Great care should be taken that the number of fish, their age, and, if possible, their weight, are the same in all the ponds; and, both in stocking and fishing the ponds, every individual fish should be weighed.

As it must be supposed that the effect of food will, as with other animals, vary according to the age of the carp, the fish placed in the ponds for the purpose of experimenting on them should be retained in these ponds until they have reached a marketable weight, or the number of experiment ponds should be increased, so that during the first year fish of every age can be placed in the ponds, there to be fed on different food. We would suggest a period of four years, even if, as is highly probable, the fish will, during this period, owing to the feeding, exceed the marketable weight. It is to be presumed that in four years sufficient data can be collected showing the influence of the weather, the food, and the different age on the increase in weight of fish. The number of fish to be placed in each pond should be those given for medium ponds. It is my firm conviction that if experiments are made in the manner indicated above they will lead to positive results sooner than if they lack this basis. It will also be well to catch a certain number of

fish at stated periods, especially during the summer months, with a view to ascertain the increase in weight during these periods.

To find the natural capacity of the different ponds for producing food, according to the difference of soil and the more or less sunny location, ponds of the same size should be constructed in different localities and be stocked with an equal number of fish. The most favorable dimensions of experiment ponds will be 10 meters in length and 10 in breadth, with a depth of water as indicated in former chapters.

These hints must suffice; and the rest should be left to the ingenuity and skill of the experimenter, which will enable him to find the shortest way to reach the desired end. Scientific education, a knowledge of the principles of fish-culture, combined with the greatest exactness in making experiments and observations, and the careful noting down of every observation, are absolutely necessary to insure success. The experimenter must be able to distinguish the essential from the unessential, and, fully alive to the great importance of his efforts, enter into the subject with enthusiasm. Only a person who is thus qualified will be able to gather all the necessary data and therefrom draw his conclusions with mathematical accuracy. A person who does not possess the necessary education, or who shuns the labor and seeming waste of time connected with such experiments, had better not attempt them. It will be a great mistake to intrust the conducting of these experiments to servants or other uneducated persons, for even if you give them the fullest and most accurate instructions, they will not carry them out fully, either from a lack of intellect or because they do not take sufficient interest in the subject. Even if they begin all right, they will soon get into a routine way of doing things and neglect one or the other of the instructions. In short, these experiments should be conducted by no one else but the educated proprietor or manager of the pond farm in person.

Supervision of the ponds.—We have to mention the subject here as the third point in the care of fish, but we deem it proper to reserve its full discussion to a later chapter, and give first all those subjects to which this supervision relates.

11. THE WINTERING OF FISH, OR THE STOCKING OF WINTER PONDS.

The object of winter ponds is to receive the older fish, and also in some cases the young fry, from ponds which, owing to their small size and insufficient depth, do not afford safe winter-quarters for fish. Besides the regular stock of fish, these ponds may also, according to circumstances, be used for those fish which are kept for sale, if there is no chance to sell them immediately after the autumn fisheries, but if it is likely that they can be sold during winter; as, confined within a narrow space, they can easily be caught whenever needed. If they were left in the large stock ponds it would frequently be impossible to catch them; and such winter fisheries will also invariably be connected with

many difficulties and considerable loss. The stock ponds should be ready to receive the fish from the raising ponds late in the autumn, and considerable difficulty may be experienced in adding to the already large number of fish in the stock ponds. On the safe wintering of the regular stock of fish the success of the entire pond farm will depend to a great extent. If many of these fish perish during the winter, the farm is thrown back for a whole year; and if the losses are very great, the consequence will be felt for several years, especially if the young fry have been injured. If such losses were to repeat themselves for two or more consecutive years, the pond farm would be unavoidably ruined. Winter ponds should, therefore, be selected with the greatest care, according to the conditions needed for such ponds, as given in a previous chapter. If for a number of years there have been no losses in these ponds, they may safely be considered good winter ponds. If, nevertheless, losses should occur, they are not caused by the nature of the winter pond, but by lack of proper supervision and management during the winter season.

The number of winter ponds must always be greater than is absolutely necessary for the number of fish that are expected to be kept during winter. Supernumerary winter ponds will often prove not only a great advantage, but they will become an anchor of safety in time of need. Thus, if an excess of young fry is caught in autumn which can successfully be brought through the winter, they can frequently be sold to advantage in spring, and there will be no necessity for placing pike in the stock ponds in autumn. Suppose, however, that from some cause or other the fish begin to droop and perish in one of the winter ponds, and the only way of escape would be to fish the pond clean, it would be exceedingly awkward if there was no other pond to which the fish can be transferred; or, to suppose another case, in what a difficult position would a pond cultivator be placed if he should find it impossible to sell all the fish from the stock ponds in autumn, without having at his disposal a supernumerary winter pond for receiving the fish which he cannot sell.

If a winter pond meets all the conditions required of it, but has not the necessary depth of water, the pipe for the outflowing water should be placed higher, and the necessary quantity of water will soon be obtained; and if this should not suffice the fish-pit will have to be dug out deeper. The principal requisite of a good winter pond is in all cases a sufficient supply of fresh water, which, however, does not imply that ponds which do not have such a supply at all times are absolutely unsuitable for winter ponds. For I know from my own experience that even sky ponds, if of sufficient size and corresponding depth, may carry fish safely through the winter, in spite of the fact that their water supply is purely accidental, subject to frequent interruptions, and often ceases entirely during a severe winter. Such ponds will have to be of larger size and greater depth if they are to become good winter ponds.

Winter ponds should be allowed to lie dry during summer, so that the soil may lose its acidity, and also to prevent the growth of aquatic plants. It will also be well to plow the winter ponds as soon as they have been drained, and so let them remain in that condition for some time; or, better still, to sow them. A short time before the fish are placed in the winter pond it should be filled with water, so as to have its full supply when the fish enter it.

The number of fish to be placed in winter ponds will depend on their size and quantity of water, on the depth of water and the depth to which it will freeze in winter, on their supply of water, and on the size and weight of the fish. Von Reider counts, according to the size and depth of a pond and its possible supply of water, 28,000 to 35,000 two years' fish per hectare, but as a general rule only 17,500 per hectare; of one year's fish, 42,000 per hectare; and of young fry, 84,000 to 105,000; and large carp only 3,500 per hectare.* Horak (without specifying what classes of fish he has reference to) counts in round figures 5,200 to 6,200 per hectare.†

Every possible precaution should be taken to prevent any transfer of fish from one winter pond to another, for if the water is low and its supply scanty this may seriously injure the fish, which are crowded in a narrow space.

Breaking holes in the ice and admitting air will not protect the fish from dangers in the winter ponds; but the only efficient means of protecting them is to give them sufficient room and a constant supply of fresh water, which will not only provide the fish with air, but also prevent the spoiling of the water, even if the surface is frozen firmly and covered with a thick layer of snow. The case is, of course, different in sky ponds, which during winter receive hardly any supply of fresh water, and here it will be a matter of necessity always to have some holes in the ice.

In order not to make the sorting of the fish difficult when the winter ponds are fished in spring and to make this process unnecessarily slow, large and well-regulated pond farms should have separate winter ponds for the different classes of fish, *i. e.*, one for the young fry if it cannot be wintered in the spawning ponds, one for the two years' fish, and one for the three years' fish (if, after the fisheries, they are not immediately transferred to the stock ponds). If other kinds of fish, especially fish of prey, are to be wintered, they should be assigned separate winter ponds, as they must on no condition share a pond with carp. Wherever it can be done, those fish of prey which have not yet reached a marketable weight, and can therefore not be sold, should immediately after the fisheries be returned to the stock pond. This applies to pike, perch, &c. If fish of prey are wintered, their winter ponds should be separate from those of the other fish. Tench also should, if possible,

* Von Reider, *Das Ganze der Fischerei*, 1825.
† Horak, *Teichwirthschaft*, 1869.

not be kept in winter ponds with carp. On small pond farms it may become necessay to keep carp of different ages in one and the same winter pond. In that case it will be well, with a view of preventing an unnecessary delay caused by the sorting of the fish and a consequent delay in the fisheries and the transfer of the fish to the raising ponds, to place in one winter pond only fish whose age can easily be distinguished. As a rule, the three years' fish are immediately after the autumn fisheries transferred to the stock ponds; but there may be cases when this transfer cannot be made at that time, and when these fish have to be wintered. In placing these fish in the winter ponds great care should be exercised to arrange matters so that the different classes of fish can easily be distinguished in spring. If the quality of the ponds varies very much it will be exceedingly difficult to distinguish the one year's fish from two years' fish, and these from three years' fish. Young fish which for some cause have been retarded in their growth are frequently not any larger during the first year in the raising ponds than young fish which have enjoyed greater advantages at the the end of their first year. In such cases the one year's fish and the three years' fish should occupy the same winter pond, and the two years' fish should share a winter pond with the stock carp (in case these have to be wintered). If the space is limited and if the pond farm is so small as to possess only one winter pond, nothing remains to be done but to put all the fish in this pond, and sort them as well as possible in spring. It will, however, in that case be almost impossible to prevent fish of different classes from getting into one and the same raising pond.

In view of the great importance of successfully wintering fry and young fish, the winter ponds should be under constant supervision during all winter, as in severe winters the great cold, deep snow, and especially the freezing of the pipes or ditches through which the water enters and flows out, may prevent fresh air from entering the pond, and may cause a vitiation of the water, owing to the lack of oxygen, which may prove fatal to the fish. The entire contents of a winter pond may be lost if fresh water is not introduced constantly and if no holes are made in the ice. If the supply of fresh water is irregular, especially in sky ponds, or when winter ponds have been overstocked, there will invariably be great danger that the fish will perish during an exceptionally severe winter. I repeat, therefore, that the overcrowding of winter ponds must be avoided.

Horak mentions the following indications of approaching danger: "The first indications of danger, which is particularly great during the latter part of winter, are small air-bubbles which make their appearance in the holes in the ice; the water begins to change its natural color; it is no longer clear, but of a brownish-yellow or whitish color, according to the different soil and mud. This change of color is also frequently caused by microscopic plants and animals, which increase with incredible rapidity and at an enormous rate. Before the fish appear

near the air-holes, there are seen in them small, and soon also large, spiders and beetles in a languid condition or dead; and one or two days later, fish begin to make their appearance in the air-holes more or less languid and gasping for breath. If the water of a pond becomes spoiled, the first to suffer and die are the crawfish, next come the frogs, then the fish of prey, and last of all the carp. At the first indication of such a condition of affairs crows begin to hover around the pond and about the air-holes, and thus become in truth birds of ill omen to the pond cultivator."*

The only help in such cases, which cannot be brought too soon, is the immediate introduction into the pond of fresh water and fresh air. The latter object is reached by quickly making as many air-holes as possible, and fresh water is introduced by freeing the ditches from ice and by increasing the depth of water as rapidly as possible. The ditches through which the water flows out should of course also be freed from ice, so that the water in the pond is kept in constant motion by the fresh water flowing through it. This process should be continued until all the vitiated water has been removed. If this cannot be done quickly enough, or if it has not the desired effect, so that fish gasping for air crowd the air-holes, and if there is no immediate prospect of thaw or rain, it becomes an imperative necessity to take all the fish out of the pond and transfer them to another one. The appearance of a few fish in the air-holes should not cause the pond cultivator immediately to empty out the pond, for these may be only fish which have fallen sick from some other cause, and have therefore sought the fresh air. Such fish should be carefully examined with a view to ascertain the actual cause of their having left the depths of the pond. Carp which are suffering in consequence of a vitiation of the water have, according to Horak, always an unusually large gall bladder, a bluish mouth, and a pale color generally. Carp which show these signs should not be used for stocking ponds.

The fish which have been removed from a pond whose water has become vitiated should not be placed in the same winter ponds with other fish; for they are languid and sick, and are apt to give their disease to the other fish. If some of the fish should die after they have been removed to another pond they will corrupt its water, and the first loss is followed by a second one. Sick fish should, therefore, be transferred to ponds which contain no other fish, and the importance of having a few supernumerary winter ponds will be recognized. In order to prevent such occurrences, or at any rate to bring speedy relief, winter ponds should at all times, but especially during severe winter weather, be kept under the most careful supervision. The water, however, may become vitiated, and the fish die, even if it is not covered with ice, unless fresh water is from time to time introduced into the ponds, and the same may occur if the winter ponds are too much crowded. Pond cultivators should, therefore, see to it that their winter ponds are

* Horak, *Teichwirthschaft*, 1869.

constantly supplied with fresh water, and often examine the ponds with the view to ascertain whether the supply is sufficient. It would be a great mistake to wait till the fish begin to appear at the air-holes gasping for breath.

It is a very general opinion that in severe winters the fish are apt to perish owing to the lack of air-holes, and the consequent lack of fresh air. I deem it proper, therefore, to give a different view which is entertained by Von Reider. He says: "If the pond is deep enough, the water flowing into it will prevent it from freezing. If the water flows out freely, the water in the pond is kept in constant motion and is therefore not so apt to freeze. The fresh water will also introduce fresh air into the pond, and there is no danger whatever that the water in the pond will become vitiated. Even if the pond is covered with ice, and the supply of fresh air from above is cut off, the water which flows in and out under the ice will keep up a constant current of fresh air, and prevent a vitiation of the water. If a winter pond, therefore, has a well-regulated supply of water, no harm will be done by a covering of ice even if the snow lies deep on it; on the contrary, it will keep off the frost from the water below, and the fish will, in the constantly running water, which owing to its cover of ice and snow is kept at a pleasant temperature, always be safe and healthy. All that has to be done in a very severe winter is to keep the ice from stopping or impeding the flow of the water. It will rarely freeze if kept in constant motion, but it will be well to give a little aid by breaking holes in the ice at the places where the water flows in and out. It is unnecessary, and may even be injurious, to make air-holes in the ice, as the cover of ice and snow is to prevent the frost from entering the depths. If, however, extremely cold weather should continue for a considerable length of time, it may happen that the water flows over the ice, and in that case it will become necessary to make holes in the ice, but only in those places where the water flows in and out. Here the ice should be removed, so the water can resume its usual course." Von Reider goes on to say that "the above statement satisfactorily settles the question whether it is useful and proper to break the ice in winter ponds. All that is needed is to secure ready access to the pond for the fresh water and to facilitate its outflow."*

Delius† is also inclined to think that there is little use in making air-holes in the ice for the purpose of a constant contact between air and water, because, as he says, the existence of the fish is already endangered when they seek the air-holes. He thinks that even if the pond is frozen and the flow of water is stopped, the fish will, at any rate in large and deep ponds, be fully protected against the danger of freezing, and that only in small ponds are they apt to become languid and seek the holes to get a breath of fresh air; and if they do not succeed in this,

* Von Reider, *Das Ganze der Fischerei*, 1825.

† Delius, *Teichwirthschaft*, p. 35.

they will float about under the ice in a dazed condition and finally freeze to the ice with their fins. Delius is of opinion that the lack of oxygen cannot cause this condition, but that it is rather occasioned by an accumulation of gases from the mud at the bottom which cannot escape through the ice, and which will be particularly strong in shallow water. While Von Reider considers air-holes unnecessary only in those ponds which have a constant supply of fresh water, Delius thinks they are not needed even in ponds which have no such supply, but which are of sufficient depth.

I am inclined to share these views, all the more as I have found them correct as regards sky ponds, but I have for my own part never omitted to make air-holes, and would not recommend any one to omit it merely for the purpose of ascertaining whether air-holes are necessary or not. The majority of pond cultivators, both in former and more recent times, consider air-holes necessary, at any rate in severe winters, and it will under all circumstances be better to be too careful than to exercise too little care. I consider it, however, injurious to make air-holes right over the place where the fish congregate, or in its immediate neighborhood, as thereby they are deprived of the protection against cold which the cover of ice affords them. In small ponds of sufficient depth, and with a continuous flow of water, the air-holes may be dispensed with, but the breaking of the ice near the places where the water flows in and out should in no case be omitted. In large ponds, where the water flows in at a considerable distance from the place where it leaves the pond, and where the current is not very strong, air-holes become an absolute necessity, and this is probably the reason that on the Wittingau pond farm, which possesses many ponds of great size, great stress is laid on supplying a large number of air-holes.

Considering the great importance of this question, it may be desirable and proper to quote some other practical pond cultivators. Tscheiner says: "In winter, when the pond is covered with a thick coating of ice, it is necessary to make holes in the ice in several places, so as to give the fish some fresh air; and to prevent these holes from freezing two sticks are stuck in them crosswise, and on these is placed some straw or brush-wood. The snow which falls on this covering of ice is probably more helpful than hurtful, because it lessens the cold, and thereby prevents the ice from becoming too thick. On the other hand, it produces darkness in the ponds, which may prove dangerous to the fish. Around the air-holes, therefore, the snow should always be swept away." *

Reimann says: "The less water flows into the pond the more and greater air-holes must be made in the ice. The same applies to large ponds, even if they should have a constant supply of water. The more water flows into a moderate sized pond, the less in number and smaller in size need the air-holes be. Ponds whose water supply is scant must

* Tscheiner, p. 193.

have air-holes at intervals of 146 meters. Air-holes should be made especially in the places where the water flows into the pond and on both sides of the pond, so as to procure a current of air under the ice."*

The number of air-holes should not be excessive, nor should they be too large, because this would deprive the fish of some of the necessary warmth. But, as Reimann says in another place, "Winter ponds, which are fed by a rapidly flowing river, or even by a good spring, will rarely need any air-holes."

Horak,† as has already been stated, thinks that air-holes are absolutely necessary; but as appears from his statement relative to the signs which indicate the approaching death of the fish, air-holes cannot altogether prevent it, as the first indication are seen in the existing air-holes, which, so to speak, become points of observation. He likewise says that air-holes are made in the ice, not merely to produce a current of air, but also to enable the pond cultivator to watch the fish in their winter-quarters. According to this author, air-holes in large ponds should be 9 to 14 meters long, .8 to 1 meter broad, and distant from each other 17 to 35 meters. They should be of considerable size, and be made in great numbers, because they are intended to keep up a current of air and act as outlets for vitiated air. Horak thinks that a pond will rarely need more than three or four air-holes, unless it is very large. Air-holes should be made as soon as the ice has reached a thickness of 5 to 7 centimeters [about 2 inches].

Tscheiner has probably hit the nail on the head when he says: "If proper care is taken to keep the water clear and pure, and if the number of fish is not disproportionate to the quantity of water and the size of the pond, the safe-keeping of the fish may unhesitatingly be intrusted to Mother Nature, who cares for all beings with equal wisdom."

The fisheries in the winter ponds take place in spring, generally in April, and are carried on in exactly the same manner as in the raising ponds; but as the number of fish will be greater, care should be taken to get through as quickly as possible, and to place those fish which are destined for the raising ponds into these at once. To try to save labor and expense by employing but few men and carts would be a great mistake. In order to carry on the fisheries rapidly and systematically, the pond cultivator should, during winter, prepare a careful plan for stocking his ponds in spring, and the material for such a plan will be furnished by carefully noting down the results of the previous autumn fisheries. As the fish do not receive any food in the winter ponds, except what may have been dissolved in the water, they will lose some weight during winter. This loss is generally 2 or 3 per cent, sometimes greater. When the fisheries have come to an end, the ponds should be drained entirely, and be allowed to lie dry during the summer. If any fish have died in the pond during winter, the pond must

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* Reimann, p. 116.

† Horak, *Teichwirthschaft*, 1869.

be sowed. On small pond farms it will be advisable, if many fish have died in the winter ponds, to supply this loss by buying fish, so as not to cause an interruption in the working of the farm. But if the losses are very heavy, it will, especially on large pond farms, become necessary to make another distribution of the ponds, or if many young fish have perished while an unusually large quantity of fry has successfully passed through the winter, to place these in ponds which, owing to the loss of young fish, would otherwise receive no fish at all. Another plan would be to sow these ponds, so as to obtain a harvest of grain or grass, and also to cause the fish which are placed in these ponds during the following year to grow more rapidly, with a view to make up for the loss sustained.

B.—*The culture of some other kinds of fish.*

1. THE TENCH (*Tinca vulgaris*).

An extensive and systematic culture of the tench will be found advantageous only in very few localities, because this fish does not find either a very ready or extensive sale, and does not grow as rapidly as the carp. There are localities, however, where tench are esteemed as much as carp, and bring as high a price. In many places the tench is a favorite soup-fish, and is sold when it weighs only one-quarter of a pound at the same price which is paid for carp. On the Wittingau pond farm tench are considered marketable when they have reached that weight. At one time I sold a good many of these fish at the same price as carp, but the lightest weight at which I could find a sale for them was 1 pound. It may, therefore, be recommended to cultivate the tench on a limited scale with the carp; but a good deal of this cultivation should be left to nature, *i. e.*, the tench are not assigned any separate spawning and raising ponds. If possible, they should not be placed in spawning ponds, as they will spawn there, and great difficulty will be experienced in separating their fry from that of the carp. The tench proves advantageous in carp-culture, as it continually roots in the mud, and thus makes the food contained in it, such as snails, worms, &c., accessible for the carp; and as it will thrive even in very poor water, it is found in the carp ponds of most pond farms. Pike are very fond of tench as an article of food; if they are to be placed in stock ponds, they should be of sufficient size to prevent their becoming an easy prey to the pike. If there should be on a pond farm several ponds in which carp will not thrive owing to the poor quality of the water, or if the ponds of a small pond farm should all suffer from this defect, it may be recommended to cultivate the tench systematically like the carp, and it may even be profitable to cultivate them extensively.

2. THE CRUCIAN (*Carassius vulgaris*).

This fish is cultivated in the same manner as the carp and the tench. The crucian can also stand poor and muddy water better than the carp.

It can, however, be hardly recommended for systematic cultivation, as it does not find a ready sale. In former times this may have been different, as we read that the crucian was cultivated on a large scale. Crucians may, under certain circumstances, prove injurious to the carp.

3. THE PIKE (*Esox lucius*).

A special culture of the pike, as of all fish of prey, must be considered inexpedient, as their principal food consists of fish, and as they destroy more than they can produce (a pike will, in one week, consume a quantity of fish equal to double its own weight), and as, moreover, they generally bring a lower price than carp. It would, therefore, hardly pay to cultivate them regularly, as this would necessitate the raising of special food-fish for them. As an addition to carp ponds they may be recommended principally to keep these ponds clear of worthless fish, which eat up the food intended for the carp, and also to destroy the superfluous fry of the carp. Carp stock ponds are therefore the spawning, raising, and stock ponds of the pike, which are here left to the care of nature. In the chapter on stock ponds hints have been given as to the number and size of the pike to be placed in each pond. On the subject of special pike ponds, Von Ehrenkreuz says: "Ponds containing many frogs are particularly suited for pike ponds. If for some years these ponds have been stocked with vigorous pike, the number of frogs decreases rapidly, and as soon as the pike have accustomed themselves to this kind of food, it is quite amusing to watch them hunting frogs. If the ponds contain no frogs, some fish of an inferior kind, which spawn profusely, should be placed in them, or some carcass should be thrown into the water for pike food. Pike will thrive best in ponds with carp weighing 2 or 3 pounds apiece, crucians, tench, &c., as these fish spawn frequently, and thereby furnish an ample supply of food for the pike. If they are to have special ponds, these should in spring be stocked with crucians and other common fish; after these have been in the pond for one year, and have spawned, pike are put in weighing one-half to three-quarters of a pound apiece; after two years they will have reached a weight of 3, 4, and even 6 pounds; and when the pond is fished it is quite probable that, besides pike, a considerable quantiy of crucians will be caught, especially if they were good-sized fish when they were placed in the pond."*

4. PIKE-PERCH (*Lucioperca sandra*).

As to its mode of life, this fish strongly resembles the pike. It increases very fast, fetches a higher price than pike and carp, and, wherever the conditions are favorable for its cultivation, it may be recommended as an addition to carp ponds. All that can be said against it is its tenderness, which makes its transportation difficult. On the Wit-

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*B. von Ehrenkreuz, *Angelfischerei*, 1873, p. 227.

tingau pond farm, where the carp stock ponds contain 10 per cent of pike, 5 per cent of pike-perch are added; and these fish, which have been cultivated here for a long time, seem to thrive. Mr. Horak, the former manager of the Wittingau pond farm, says: "A goodly number of pike-perch is always welcome in the fisheries; if, however, their number becomes excessive the consequent loss of weight in carp is not compensated thereby. The proper proportion between the number of carp and pike-perch should therefore not be lost sight of. In a pond with cultivated fish the pike-perch forms an unruly and disturbing element, and, if in large numbers, becomes injurious to the carp. It does not only live on fish, but also on insects and worms, and thus deprives the carp of its food. Its prickly fins become sharp weapons of attack, which the carp fear with good reason. As there are no separate spawning ponds for fish of prey, they must be placed in the carp ponds. From a small stock of the fry of pike-perch a strong breed of fish cannot be looked for with absolute certainty, although it may sometimes be the case. To obtain the necessary quantity of fry of the pike-perch in carp ponds it is advisable to put spawning pike-perch in these ponds at the time when the carp are approaching their full growth."*

5. THE PERCH (*Perca fluviatilis*).

Horak says, regarding this fish: "The perch is a good fish, possessing delicate flesh and a very hardy nature, but it is a fish of prey which also devours the carp food. In large numbers it becomes dangerous to the carp, and should not be cultivated, but left to shift for itself. Its prickly fins make it a dangerous companion for the carp, which, especially after thunder-storms, it drives away from the edges of the pond, and thus prevents it from obtaining its necessary food." I have nothing to add to Mr. Horak's remarks.

6. THE SILURUS.

The silurus is a voracious fish of prey, which, like the pike, can be kept in carp ponds, and which, when it has reached a size which makes it dangerous for the carp, should be caught.

7. THE LOACH (*Cobitis barbatula*).

As I have never raised loach, and never had an opportunity of observing loach culture, but at the same time consider it profitable, I have to quote from other authors on the subject. According to Delius, loach are sometimes raised in ditches fed by running water. Their food consists of excrements and refuse. The loach is a favorite food-fish, and has the advantage that it can be caught all through the summer when it is difficult to obtain other fish. They may also be raised to provide food for trout. The bleak and minnow, however, will answer the same purpose.†

* Horak, *Teichwirthschaft*, 1869.

† Delius, *Teichwirthschaft*, p. 74.

B. von Ehrenkreuz says: "Wherever the opportunity offers, the culture of this delicate fish in ditches should not be omitted simply because it involves a small expense. These ditches are nothing but small brooks, with gravelly or sandy bottom, whose sides are lined with boards, and in which perforated pieces of tin have been placed through which the water can flow in and out freely. In these ditches the loach are fed on the excrements of sheep, poppy-seed, linseed-cake, the entrails of various animals, refuse, husks, cooked grain, potatoes, bread, &c. As they increase very rapidly in these ditches, it is advisable and even necessary to have two or more of these ditches in the neighborhood, one for the spawning fish, the second for the fry, and the third for those loach which are to be fattened for the table. The basins of fountains are also suitable for loach-pits; care should be taken, however, that no injurious substances, *e. g.*, soap, lime, &c., get into it. If loach are to be raised in ponds, they must have a supply of fresh running water and be of small size, so that the wind does not create waves, which the loach cannot stand.*

8. THE GOLDEN IDE (*Idus melanotus*).

The culture of the golden ide may be recommended in localities where there is a demand for these fish as ornamental fish for the basins of fountains, and they can be raised like the tench by being allowed to shift for themselves.

9. THE GOLDFISH (*Cyprinus auratus*).

The culture of the goldfish is subject to the same rules as that of the carp. They also need separate spawning, raising, and stock ponds. Goldfish need warm water, and therefore small, shallow ponds. Special care should be taken to keep away all animals which may prove injurious to the goldfish, and frogs especially must not be allowed in goldfish ponds. These ponds should have as little vegetation as possible. For these reasons goldfish can but rarely be successfully raised in natural ponds, and it will be well to construct for them small, shallow ponds, every portion of which can easily be watched. Although the goldfish, like the carp, are not very choice as to the quality of their water and food, and are not easily influenced by changes in the weather, the spawning ponds should not be stocked before May or June, as these fish require very warm water. To every three milters there should be two spawners, or one spawner to two milters. If the bottom of the pond is rich in food, no artificial food is needed; but if the bottom is sandy or strong, the goldfish must be supplied with food, consisting of linseed-cake, the dung of cattle or horses, broken into small pieces, bread, cooked or crushed peas, &c. The raising of goldfish may prove very profitable, but it needs constant care and attention. During winter goldfish, like carp, must be transferred to deep ponds.

*B. von Ehrenkreuz, *Angelfischerei*, p. 177.

One of the largest goldfish establishments is that of Mr. Christian Wagner, at Oldenburg. It extends over a moist peaty bottom, embraces an area of about 3 hectares, and consists of 120 ponds, measuring about 100 square meters each, and separated from each other only by narrow dikes. These ponds receive their water partly through ditches from the river Hunte, and partly from a factory, and from other ponds. By means of steam the temperature of the water can be raised to from 30 to 50 degrees R. [99½ to 144½ degrees F.]. The ponds are divided into (1) spawning ponds, (2) raising ponds, (3) ponds for hardening the skin of the fish, and (4) coloring ponds.

The spawning ponds and the ponds for hardening the skin of the fish are fed principally by water coming from the bottom of the ponds. The water of these ponds is almost stagnant, but is occasionally agitated by leading river water into the ponds. Although the water in these ponds is occasionally only 15 centimeters deep, their usual depth is about 60 centimeters, and near the outflow pipes as much as 120 centimeters. The bottom of these ponds, which is purposely kept uneven, is here and there covered with aquatic plants, on which the goldfish like to deposit their eggs. Owing to the artificial heating of the water and an abundant supply of the best and most nourishing food, the majority of the fish in these ponds reach their sexual maturity in the twelfth month, and spawn two or three times a year. Under favorable circumstances the first fry is obtained in March or April; the second fry is forced, so as to make its appearance in July or even sooner; and the the third generally comes in August or September. The female fish are changed round from time to time, so that the same females and males do not remain together too long. In rare cases a goldfish is capable of spawning for more than three years. To supply the fry with suitable food, especially insects, the raising ponds are drained seven to eight weeks before they are stocked with fry, and are allowed to lie dry during that period. The natural food is occasionally supplemented by blood in clots or lumps, refuse from slaughter-houses, or malt germs, all of which are placed in shallow portions of the pond. If this method of feeding is applied, the fry will double their weight in one week, and reach a length of 3 to 6 centimeters in autumn. Their marketable size, however, they do not reach till the end of the second summer. Rapid artificial coloring is obtained by water containing iron, lime, and tannin. Mr. Wagner's ponds contain a good deal of iron, but in spite of this he increases its quantity artificially. Fish in the Prussian (black and white) and German (black, white, and red) national colors are in great demand, and by undergoing a suitable treatment a fish which is originally red and white can easily be transformed into a black, white, and red fish. If fish which have reached a suitable size for globes or aquaria, do not show the proper color, they are placed in the coloring pond, where they are exposed to the rays of the sun which soon completes their coloring. Occasionally, however, the sun may prove dangerous,

especially if the bottom of the pond has a very light color, and if there is an absolute lack of shade; under these circumstances the fish become blind or die. To make goldfish less tender, so that they can easily be handled, they are placed in the ponds for hardening the skin. The water of these ponds contains a great deal of iron, and by adding some lime it has the effect of rendering the skin of the fish very hard. In spite of this hardening process, it is not immaterial in what kind of water the grown goldfish are kept. Mr. Wagner recommends, above everything else, spring or pump water, and where this cannot be obtained, river water. In his opinion meat, either cooked or raw, and scraped fine, worms, insects, larvæ, ant-eggs, &c., are the best food for goldfish in globes or small aquaria. These receptacles for goldfish should always contain a few aquatic plants, as *Lemnaceæ* or *Potamogeton*. Too much food becomes injurious, and it is better not to feed the fish at all for a whole month, than to give them too much food. Under no circumstances should more food be given than can be eaten at one time. Prior to sending the fish any distance Mr. Wagner lets them fast for a week, and thus prevents them from polluting the water during transportation. The vessel in which the fish are transported is an oval keg with a perforated bung on the upper side. To keep the water in motion, and introduce fresh air, the keg is never filled entirely. The number of goldfish raised annually in Mr. Wagner's establishment is about 300,000. Mr. Wagner employs a book-keeper, a night-watchman and fifteen laborers, all of whom he pays good wages, and the net annual profit accruing to him is very considerable. The same area used for agricultural purposes would hardly support one family.

10. THE BROOK TROUT (*Trutta fario*).

As brook trout always command a good price, their culture will pay three and four times better than that of carp, provided cheap food can easily be obtained. To raise trout systematically on a pond farm, ponds are required which are fed either by springs or a small gravelly brook, and on whose banks are found aquatic plants and shade-trees, like the alder. If there are no such trees, they should be planted. For trout-culture, as for carp-culture, there are needed spawning places, raising ponds, and stock ponds. As trout differ greatly in their growth, there should be enough ponds to place all fish of one and the same size together, because otherwise the large fish will devour the smaller ones. Care should be taken that no mud accumulates on the bottom of the ponds where there should always be found some large stones under which the trout may hide. The bottom of the ponds must not be gravelly, as this may induce the trout to spawn in them. In place of spawning ponds one should either have suitable spawning ditches, or the fish may be allowed to spawn in the springs or brooks which feed the ponds. Ditches will be necessary if the spring or brook has no gravelly or sandy bottom, if it does not offer sufficient room, or if the water has too little

fall. In these cases the bed of the brook is, according to circumstances, widened ½ to 1 meter, and about 15 centimeters fall is given to every 6 meters length. The depth of water should not be below 10 or above 30 centimeters. The bottom is covered with coarse gravel to the height of 10 centimeters. The ditch must slope gradually towards the bottom of the pond. If the fall is more than 15 centimeters in 6 meters, a few boards may be placed across the ditch or brook, which at one side have an opening for the fish to pass through. The depth of water, however, should not be raised by these boards above that given before, as the trout like to spawn in shallow water. The boundary line of the spawning place should be indicated by a very narrow grate, so the fry cannot escape and go up the stream to the spring. Above this narrow grate there should be a common grate for keeping off mud, dry leaves, &c. After the trout have deposited their spawn they are driven back into the pond, and the spawning ditch is also closed towards the pond by a very narrow grate. In this spawning ditch the fry are left for one year; or if the old trout have spawned particularly early, the fry may be placed in a pond in spring. If the natural condition of the spring or brook which serves as a spawning place meets all the requirements mentioned above, nothing need be done but to fence off the spawning place by grates. To protect the eggs and fry against their enemies, the spawning ditch is covered with dry brush-wood, but not so close as to prevent a current of air from passing through. Every year, before the spawning season commences, the ditch should be cleaned of mud and aquatic plants. As soon as the young fish have slipped out of the eggs, hiding-places should be provided for them, which can easily be done by placing in the water good-sized stones, hollow tiles, &c. If there are no aquatic plants, such as water-cresses—which, if not found in the ditch, should by all means be planted—and if there are no shrubs or trees on the banks to afford shade, the covering of brush-wood should be made thicker in some places. To provide both currents and calm places, small boards are placed in the ditch at suitable places, of course with openings for the little fish to pass through. The temperature of the water in the spawning ditch should not exceed 12° R. [59° F.]. Seventeen degrees are dangerous, and 23 become fatal. To prevent a rise of temperature in very hot weather, more brush-wood can be piled on the ditch. The fry need not be fed, if there is in the ditch a sufficient quantity of aquatic plants such as *Lemnaceæ*, *Nasturtium officinale* (water-cresses), *Veronica beccabunga*, &c., for these plants are always inhabited by numerous diminutive animals which serve as food for the fry. These plants are planted in the ditch simply by laying the roots on the bottom and placing stones on them to prevent the water from carrying them off. It is also advisable to introduce into the ditch insects, especially of the genus *Gammarus*, which is done in a very simple manner, by catching these insects in stagnant water, where in the beginning of spring they are found in enormous numbers, and transferring them to the ditch.

According to Meyer, infusoria may easily be procured in the following manner: "Take a large glass vessel, put at the bottom fresh leaves and other parts of plants, on the top of these some animal excrements (particularly those of cattle), and on these another layer of leaves, fill up with water and place in the sun, when in a very short time an enormous number of small crustaceans and infusoria will develop, which form the favorite food of young trout. To use these diminutive animals for trout food, a quantity of the animated water is filtered through a small dipper of mull, by which process a residue is left, which on close examination is found to be composed of thousands of animalcules."*

Before another spawning period commences, the one-year-old trout are taken to the raising ponds, and the ditch is given a thorough cleaning. As to the general requisites of raising ponds the necessary information has been given in a previous chapter. As regards their depth it should be stated that for one-year-old trout it should be 60 centimeters, for two years' trout 120 centimeters, and for older trout 1.5 meters, which is also a sufficient depth for wintering trout. If the fish in the raising and stock ponds are not to be fed artificially, their number will be determined by the quantity of natural food contained in these ponds. If it is necessary to use artificial food, it will be best, to prevent any pollution of the water, to use only live animals, such as maggots, fish-fry, worms, &c. Besides vegetable food, animal food may also be introduced into the ponds by adding to the trout some small fish, such as loach, minnows, &c., whose fry serves as food for the trout; but this method will have the disadvantage that these fish will devour many of the worms and insects which were intended for the trout, and on the whole, therefore, it cannot be recommended. To use scraps of meat as food can be only recommended if the quantity is very small and in small tanks, so that it can be eaten up at once, and, if necessary, the remainder can easily be removed from the water, which otherwise is apt to become polluted. Von dem Borne says that the time when the trout is most voracious is in spring, while in hot weather it eats but little. During the spawning season, and during winter when the temperture reaches zero (R.) [32° F.] trout do not eat anything. Trout should therefore never be fed during the noonday heat, but early in the morning and in the evening. As for the rest, all that has been said regarding carp-culture also applies to trout-culture, of course with such modifications as the nature of the trout demands.

11. SALMON (*Trutta salar*), SEA TROUT (*Trutta trutta*), AND LAKE TROUT (*Trutta lacustris*).

We cannot properly speak of culture as regards those kinds of fish whose young are not produced on the pond farm, but have to be obtained from abroad. To the keeping, therefore, of salmon, sea trout, and lake trout, all that has been said relative to trout-culture will apply

* Meyer, *Praktischer Fischzüchter*, p. 62.

as a general rule; and I would only call attention to the necessity of obtaining the fry in an embryonic condition or of getting young fish from fish-cultural establishments. Mr. Kuffer, of Munich, has informed me that in his establishment he has raised salmon-trout weighing 3 pounds and more. His establishment is fed entirely by pure spring water, which comes from the top of the hill on which the establishment is located. It consists of some very small shallow ponds and a number of granite tanks. As food, he generally uses the entrails of fish but also live and dead fish. As these different kinds of fish have been successfully raised in various localities, and in other than spring water, experiments on a small scale, according to the method given for the raising of brook trout, may be recommended. These experiments can be made only where besides large, there are also a number of very small, ponds. Large ponds are never suitable for experiments, in the first place because they are difficult to overlook, and secondly because, in case of failure, the loss would be doubly great, as a large pond area would be rendered useless for carp-culture. If the experiments should prove successful, the culture of these fish may be carried on more extensively.

12. THE VARIOUS KINDS OF COREGONUS.

To the keeping of these fish we may apply, in a general way, what has been said regarding the salmon. I cannot urge fish-cultivators too strongly to bring both these kinds of fish within the reach of pond culture, as I feel convinced (if I prove a false prophet I shall be greatly pleased) that by fish-culture and the placing of fry in open waters the number of the finer kinds of fish will increase to such an extent as to lower the price of carp, so that pond cultivators will find that exclusive carp-culture does no longer pay, and that it will have to be confined to those pond farms where it is impossible to raise or keep the finer kinds of fish. Experience has proved that the raising or keeping of the finer kinds of fish is in most cases successful. As an illustration, and for the encouragement of enterprising pond cultivators, I shall quote the following, relative to the keeping of the *Coregonus marœna*, from a report by Mr. Eckardt in Lubbinchen, near Guben.*

According to a report of Mr. A. Stenzel, inspector of fisheries, in No. 7 of the Circulars of the German Fishery Association for 1875, it appears.

1. That the *Coregonus marœna* grows rapidly.

2. That proof has been furnished that this fish, by means of artificial culture, can be planted anywhere in suitable water, and that it will soon accustom itself to a different quality, depth, and temperature of water, and to a different food.

3. That the very general but erroneous opinion that the various kinds of *Coregonus* which live in lakes could only thrive in these, has been

* *Deutsche Fischerei-Zeitung*, 1878, p. 10.

thoroughly refuted by the simultaneous successful experiments in raising these fish in ponds made at Lubbinchen and Tankow. It has also been shown that the *Coregonus maræna* (and probably other kinds of *Coregonus*) will thrive in water containing iron and coming from peat-bogs; and that it can, in comparatively small ponds, by feeding, be developed to one year's fish, and very probably be raised to any desired age. The various kinds of *Coregonus* should therefore be brought within the reach of pond culture; and for this purpose special *Coregonus* ponds should be constructed.

4. By numerous experiments it has been proved that *Coregonus*, even when placed in ponds which in every way were well suited for the purpose, did thrive, but would never propagate. The reason for this must be found solely in the peculiar manner in which the *Coregonus* spawns. If the spawning of the *Coregonus* is to be successful, the number of spawning fish should be very large.

5. Five years' experience in the Tietzel Lake has proved how well these fish thrive. This lake covers about 10 hectares and is 20 meters deep; it contains clear, soft water, is not fed from any outside sources, and is amply supplied with fish-food, principally tadpoles, small fish, *Gammarus pulex*, various kinds of snails, mussels, &c. The bottom is composed of clayey marl, and is thickly covered with aquatic plants.

Mr. Eckardt adds, that in 1877 he raised in his ponds *Coregonus* nineteen months old which measured 32 centimeters in length, and that these fish also thrive in marshy ponds. He gives the following hints for introducing these fish in lakes and ponds:

1. Proprietors of hatcheries should buy impregnated *Coregonus* eggs and have them hatched in their establishments. Eight days after the young fish have slipped out of the eggs they should be placed in lakes or in protected ponds containing no other fish. The latter will probably be the better place.

2. Proprietors of lakes without hatcheries or ponds may scatter the impregnated eggs in the lakes in places where the bottom is sandy, taking care that the eggs do not accumulate in any place, so that no spoiled eggs, which are soon covered with mold, spread disease among the healthy eggs.

3. Mr. Eckardt states that *Coregonus* eight to twelve days old may be ordered direct from his establishment at Lubbinchen. The management and feeding of *Coregonus* in winter is like that of the brook trout.

13. THE EEL (*Anguilla vulgaris*).

As at present eels fetch a pretty good price, and as young fry, called in French *montée*, can be obtained comparatively cheap from the Huningen establishment, the keeping and raising of these fish is well worth the attention of every pond cultivator. As soon as eels have reached a suitable size they form an excellent addition to the pike in carp stock ponds. It cannot entirely supplant the pike, because it is

said not to propagate in fresh water, and eats only small fish, while the large, worthless fish contained in the carp ponds can be destroyed only by the pike. There is this disadvantage connected with the keeping of eels: that they will deprive the carp of some of their food, as, besides small fish and roe, they also eat worms and insects. This applies, however, also to the perch-pike, the keeping of which, nevertheless, is profitable, when confined within certain limits. Eel ponds must have high banks, so that the eels cannot easily escape, as on moist grass they can move for the distance of several kilometers, and thus be enabled to reach other ponds. The ditches by which the pond is fed and through which the water flows out should, therefore, be closed by narrow grates. All places on the sides or the bottom of the pond where the eels could escape must be carefully stopped up. Eels should never be placed in ponds with a peaty bottom, through which they can work their way. Eel ponds should also have hiding-places consisting of stones, roots, holes in the banks, &c.

In good carp ponds the feeding of eel fry may, during the first year, be left to nature. If artificial food is needed, the same should be used as for brook trout. Food may also be supplied by placing in the ponds crucians, tench, &c., whose fry will form an excellent food for the eels. During the first year they generally reach a length of 8 to 10 centimeters and a circumference of 2 to 3 centimeters, and I have repeatedly seen eels of that age and size which Mr. Kuffer, in Munich, had received from the Huningen establishment. He keeps about twenty eels in a tank, measuring hardly a square meter and fed by spring water. In this tank he has thrown pieces of coarse ticking, under which the eels hide. For food he uses roe and the entrails of fish cut fine. The Huningen establishment charges 9 marks [$2.25] for 1,000 *montée*, 2,000 of which go to a pound. Orders should be sent in February or March. Mr. von Stemann, in Rendsburg (Holstein), and Mr. Brüssow, in Schwerin (Mecklenburg), also sell eel fry. It is to be hoped that this useful fish will soon be caught in many of our North German rivers.

V.—The Pond Fisheries.

Pond fisheries take place partly in spring and partly in autumn. In spring the first fisheries take place in the winter ponds, with a view to supply fish for the spawning and raising ponds, and after a while those spawning ponds have their turn in which fry had been left during winter. The fisheries should not commence until there is no longer any danger of spring frosts; therefore some time between the end of March and the end of April. First the winter ponds are fished and next the spawning ponds. It is of course necessary that those ponds which are to be stocked with fish from the winter ponds should receive their full supply of water before the fisheries commence. The autumn fisheries are intended partly to supply the grown carp for the market, and partly to transfer younger fish from the raising ponds to the winter ponds. They

generally commence about the beginning of October; on large pond farms, however, they should commence sooner, so they may be brought to a close before frost sets in.

For fishing, cool days should always be selected; and fishing should commence very early in the morning, so that one or more ponds may be finished before the sun stands high in the heavens, as heat makes the fish languid and renders them unfit for transportation. No more ponds should be drained during one day than can be fished that day.

As regards the order of the autumn fisheries in the various ponds, it will be best to make the beginning with those spawning ponds in which no fish are to be wintered, so that the fisheries in these ponds may be brought to a close before frosts, or even hoar-frosts, which are injurious to the fry, set in. Next in order come the stock ponds, and among them first those which are to be filled with water immediately after the close of the fisheries, so that they can be stocked that same autumn; next come the raising ponds, which are to supply the fish for the winter ponds; and lastly those raising ponds whose fish are during that same autumn to be transferred to the stock ponds. As regards the fisheries in the raising ponds, it will be advisable to take those ponds in close succession whose fish are to form the stock of one and the same winter pond. Before the fisheries commence it will, especially on a large pond farm, be necessary to prepare a well-arranged plan, taking special regard to the length of time which each pond will need for draining.

At the beginning of the fisheries the necessary apparatus, which should have been looked over some time previous in order to make any needed repairs, should all be ready; and the required laborers and carts should be on the spot, so that the fishing, sorting, weighing, and transporting of the fish may proceed as rapidly as possible, to prevent the fish from reaching their winter ponds and other ponds and tanks in a languid condition. The apparatus used for fishing and for the sorting and transporting of fish will be described in another chapter.

Letting off the water.—Before fishing commences in a pond, the water should be let off. This matter is intrusted to a reliable person, who has charge of and supervises all the preparatory labors, and whose duty it is to have the pond completely ready for the fisheries. Before the water is let off, it is necessary to carefully examine the tap-houses and fish-pits, and if needed, to clean them, to substitute new stocks for broken ones in the grates, and to clean the ditches through which the water flows off, so that it flows out evenly, without causing an inundation. If, however, there are meadows below the ponds inundations will actually prove beneficial, while if the ground below the pond is occupied by other ponds, they will be injurious. In this latter case measures should be taken to prevent any damage to dikes and dwellings, and to hinder the fish from floating away. The pond should therefore be drained slowly. At the places where the water flows out, nets should be securely fastened in front of the grates, so that no fish can get through

and reach the outer fish-pit. As fish generally get hurt in passing through the pipes, no fish should, if possible, be allowed to enter them. The outflow of the water is regulated by stand-pipes and taps, by opening them gradually and letting the water pass through by slow degrees.

After these preliminaries have been finished, the weirs, wherever there are such, are opened; and where there are stand-pipes the small boards are taken out one by one. Even if they are fastened with screws or nails, this can soon be accomplished with a screw-driver or a pair of pincers; and it will, therefore, be well to have these tools near at hand.

Where there are tap-houses, the drawing of the taps will occasion a little trouble, and will always require the combined efforts of several laborers. Short taps can, as a rule, be drawn by one strong man. For the drawing of long taps special contrivances are needed, and two, and often more, men. If the tap is not too long and heavy, it may be gradually lifted by means of a pole stuck through a ring at the top, or a hole in the tap itself. Very large taps can be drawn only by means of a very stout and long pole with holes, and shaped like a roller, of such a length that it can easily be placed on the tap-house from the dike, so as to project beyond. This pole is placed close to the tap, and round it is wound a chain fastened to the tap from below (a stout rope may also be used), whereby the tap is gradually drawn from its hole. If earth has been rammed down round about the tap, it is rocked up and down until the earth becomes loose. In thus rocking the tap up and down, it will be easy to hold it suspended for a while, and thus to regulate the outflow of the water. In the beginning the tap should be drawn gradually so that the water can flow off slowly, and the fish may gradually be drawn from the edges of the pond towards the deep places. Great care should be taken in ponds having many reeds, because the fish are apt to remain among these, and either perish or become the prey of birds and other animals. While the water flows off, some men should be engaged in driving the fish from the reeds into the deep places.

One man should always be stationed at the place where the water flows out; the outer fish-pit should also be under constant surveillance, so that the fish which may get into it accidentally can immediately be removed. If, as is frequently the case in small ponds, there is no outer fish-pit, baskets should be placed where the pipes open on the outside of the dike, in such a manner that the water flows through them, and that any fish which may accidentally have got into the pipes are caught in these baskets. The water should not be brought to its lowest level until everything is ready for the fisheries. At the moment when the tap is lifted entirely out of its hole the tap-basket is placed in the opening by which fish are prevented from escaping, but which lets the water flow through. In spite of this precaution fish will sometimes reach the outer pit, owing to the fact that the water occasionally lifts the tap-basket from its position.

The degree to which a pond is to be drained depends on its size, and

whether a seine or small net is used in fishing. In the former case the water should not be drained off as much as in the latter, and should be left to stand in the fish-pit to the depth of one meter, as otherwise the fish will be injured by an excessive accumulation of mud. If it requires several days to drain a large pond the operation should be occasionally looked after during the day; and during the last days should be watched constantly, partly to regulate the outflow of the water and partly to prevent thieving.

Other preparations for the fisheries.—Before fishing commences the necessary number of tubs, filled with a sufficient quantity of water, should be placed along the edge of the fish-pit; baskets or large pieces of cloth, for carrying the fish to the kegs, should be in readiness, and the required number of persons for attending to this work and for drawing the nets should be on hand. Particular care should be taken that there is no lack of carts, placed in convenient positions, for if the fish, after having passed from the pond to the tubs, and from these, after having been sorted, to the kegs, have to wait any length of time for the cart the tubs will become too crowded, and it may even at times be necessary to stop the fisheries for awhile. Thus the entire process is retarded, and will take twice as much time as if everything had been in readiness. By such delays the fish are apt to become languid in the tubs, they cannot stand the hardships of transportation, reach the pond in an exhausted condition, and many die. It would, therefore, be false economy to try and save laborers and carts in the fisheries. It should be remembered that the death of one fish occasions a greater loss in money than the daily wages of a laborer, and that the loss of several fish exceeds the daily cost of a cart. After everything has been prepared, and the pond has been drained, fishing commences.

If in a large pond a seine is used, it is set at some distance from the fish-pit, in a place where, after the pond has been drained, the water gathers, and it is held in a perpendicular position by a number of men, who gradually approach the fish-pit, and drive the fish before them by beating the water with sticks. When they arrive at the fish-pit, the seine is drawn through it by pulling both ends towards the shore. The two ends are gradually brought closer and closer, and are finally pulled ashore, where all the fish are inclosed. If the seine corresponds in length to the extent of the pit, all the fish will certainly be caught at once. Reimann says: "With a view to get all the fish together in the seine, care should be taken that from the very beginning the lower part of the seine rests on the bottom of the pond and leaves no openings through which the fish can escape below the seine."* In very large ponds it will be necessary to use one or several boats in setting and hauling the seine.

If the ponds have other holes besides the fish-pit, fishing should commence in the smaller and end in the larger ones. In small ponds which

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*Reimann, *Praktischer Abriss der Fischeri*, 1804.

have no deep holes and only a a small and shallow fish-pit, a purse-net is used—an instrument which is indispensable in pond fisheries, and cannot be done without, even when a seine is employed, as the fish are by it taken from the seine. Once begun, the fisheries must be brought to an end as rapidly as possible.

The size of the pond, the number of its holes, and finally the quantity of fish will determine the number of men to be employed. In no case will it be a disadvantage to employ a large number. Some enter the pond with purse-nets, others place baskets and buckets by their side, which, when filled, are immediately carried to a tub and emptied into it. Those men who take the fish from the water empty their purse-nets in the tubs or baskets which are close by them. With a view to expedite matters, an empty basket or bucket is immediately put in the place of the full one. In a large pond, even a great number of men, if fully supplied with the necessary apparatus, will not interfere with each other. Some experienced and trustworthy men should exercise a careful supervision over all parts of the pond, to prevent the stealing of fish and their being retained in holes, grass, reeds, or mud. Some men have a peculiar skill in treading fish into the mud during fishing, with the view of taking them out when the fisheries have come to a close; others manage to slip them under their baggy trousers, which are firmly tied at the ankles.

To remove the fish from the pond in baskets will be necessary only when holes in the pond are to be cleared of fish, or when the fish-pit is not in the right place, and consequently the distance from the pond to the tubs is too great to allow of their being emptied direct from the purse-nets into the tubs. If the fish-pit is large enough to haul a seine, this should by all means be employed in preference to the purse-net, as thereby the fish are kept in the water all the time till they are transferred to the water in the tubs. If the purse-net is employed exclusively, the fisheries should commence in those places where the fish, owing to a scarcity of water, lie in the mud, and gradually following the greatest depth of water in the ditches, proceed towards the fish-pit where the fish have gathered. If fish are taken from the pond with the hand, which becomes necessary when they lie in the mud, they should be taken round the middle of the body, or by the head and tail at the same time, and not be held in the hand long but carried to the tubs by the shortest road. Great care should be taken not to catch the fish by their tender gills or to have the fingers on their eyes. The laborers employed in fishing should be strictly enjoined to handle the fish as carefully as possible, and especially not to throw them into the tubs from a distance, as the fish will occasionally fall on the edge of the tub and be hurt or killed. The general rule will always be to take the fish from the pond with the purse-net. This will, however, be impossible as regards small fish, and more particularly fry, which must be carefully taken up with the hands. In emptying the purse-nets in the sorting-

baskets or in the ordinary baskets and tubs, one should proceed very slowly, so that the fish do not strike the bottom of these receptacles or each other violently and be injured.

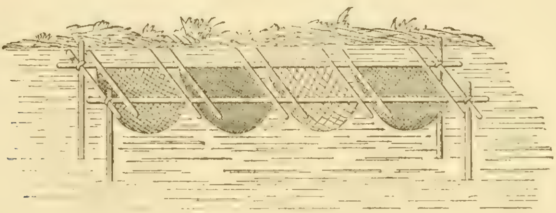
In fishing a stock pond containing several kinds of fish, the tender kinds should be removed first, as much as possible at least; perch-pike, being the most tender, should be taken from the seine singly with the hand, be placed immediately in tubs filled with pure water, and thence as soon as possible be removed to the kegs, as they cannot live long out of the water; then follow the larger pike and perch, the carp and the tench, and finally the smaller pike. Eels must be caught with special purse-nets, and not with the hand; as eels will entwine themselves around the arm, and sometimes break it. Special care should be taken to clear the ponds of fish, as eels, tench, and pike will hide in the mud and thus escape the attention of the fishermen. It is especially important that no fish of prey should remain in the pond, as these, in case the pond is filled with water soon after the fisheries, would in the following year make sad havoc among the carp. If not so dangerous, it is, nevertheless, injurious to leave large carp in the pond, as they will spawn during the following year, which will not prove an advantage from a fish-cultural point of view.

In order to remove fish which have remained in the pond, it will be advisable, immediately after the fisheries, to go through the mud with a long broad-pronged dung-fork. To be absolutely certain, it may be recommended to secure the place where the water flows out, if there is no outer-pit, for a few days with a basket, in which the remaining fish will be caught. This may be particularly useful when there is reason to suppose that some eels have remained in the pond, as these fish are very apt to hide in the mud, and leave their hiding-places only during the night or the following day. For transporting eels very tight baskets are needed. During the fisheries the water in the fish-pit should, wherever the circumstances allow it, be renewed as often as possible, so that the fish are not covered with mud and thereby become languid. Before being placed in the kegs they must be washed clean. On some pond farms a ditch measuring 1 meter in depth and of corresponding breadth and length, and located near the outflow of the water, is substituted for tubs. This ditch is filled with water from the pond. Here the fish are sorted, and thence they are taken direct to the kegs. I am not in favor of this arrangement, as it will be impossible to make separate ditches of this kind for every species of fish, since it would make too much work to dig and again fill a number of these ditches, but if they remain unfilled from one fishery to another it cannot be avoided that, especially in rainy weather, when the water of the ponds overflow the banks, these ditches will be filled with water. In such ditches the fish like to gather, and thus become an easy prey to fish thieves. I must here state that I speak from experience, although among the 50 ponds which at one time I had under my care, there was only one which had

such ditches. If these ditches are outside of the pond, on the other side of the dike, they can be secured against being filled with water, but in that case they will have the disadvantage that the labor of fishing is retarded, as the fish cannot be taken direct from the pond to the kegs, but have to be carried over the dike to these ditches—which, if not in clayey or loamy soil, must be lined with wood-work—have to be sorted in them, and finally carried to the kegs which are on the carts or wagons, which as a rule must drive on the dike. Such delays may be avoided by placing near the fish-pit a sufficient number of tubs, which make it possible to carry on the fisheries with the utmost regularity.

On some farms, tubs or ditches are dispensed with, and in the nearest pond a scaffolding of poles is erected near the shore, on which are

Fig. 19.



placed a number of nets which hang down into the water. From the baskets or nets the fish are thrown on the ground, and are thence put in the nets, assigning a separate net for each kind. This arrangement offers the advantage that the fish remain in pure, fresh water up to the moment when they are placed in the kegs, but on the other hand it will often be found difficult to get close enough to these nets, some of the fish in being thrown will strike the poles and will be injured or killed, while others will fall beyond the nets in the open water and thus escape. As some of these nets have wide and others narrow meshes, to suit the different kinds of fish, it will often happen that mistakes are made in throwing the fish, small ones sometimes getting into nets with wide meshes which favor their escape. If among these escaped fish there should be some small pike, they will, during the following year make great havoc among the fry. Frequently the number or size of these nets is not sufficient for the different kinds of fish; the nets become crowded; the lower fish seek to rid themselves of the fish which are on top of them, and in the general commotion caused thereby, many fish escape into the pond. The whole arrangement, moreover, consumes considerable time in its construction.

Much time is also wasted in employing a method, mentioned by Delius, according to which the fish are not sorted until they arrive at the tanks or winter ponds. Delius says, regarding this method: "The fish which have been caught in the pond are put on wagons, either loose or in baskets, and driven to the tanks. Care should be taken that

the baskets, which are made of willow branches with the bark on, have no sharp points on the inside; such points must always be on the outside, because the carp may be injured thereby. The carts or wagons should have a removable board at the end, and no sharp points or edges on the inside. Arrived at the tanks, the back-board of the cart is reremoved and the fish are rapidly emptied into a large tub placed immediately under the back of the cart. Close to the tub is placed an immense table with high edges, on which 300 to 400 pounds of fish can find room. This table is perforated so that the water can flow off. The fish are taken from the tub with a large dipper of muslin or other thin material and laid on the table, where, if necessary, pure water is poured over them. The fish are counted, putting the same number in each basket, so that only the number of baskets need be remembered."* The only advantage of this method seems to me to be the transportation of the fish in wagons instead of in kegs, but this will be an advantage only so long as the distance to be traversed is not very great. Although I will not altogether condemn this method, I cannot speak in favor of it. From the description of the well-regulated fisheries on the Wittingau pond farm, which I shall give in another chapter, the waste of time connected with this method will become apparent to every reader. It therefore follows that the most suitable and expeditious method of fishing the stock ponds is this: The fish are removed from the seine (or direct from the pond) with purse-nets and placed in the fish-baskets, which lie close to the tubs placed along the sides of the fish-pits; here they are washed, then sorted and put in the different tubs, weighed, and transferred to a lined tub. From this they are counted into cloths, which extend to the kegs, and are held by a number of persons. As soon as they are in the kegs they are carried to their final destination. To avoid mistakes, it may be well to attach to the tubs labels indicating the kind of fish contained in them. If a pond farm is carried on systematically it is absolutely necessary, with a view to book the results, to sort, count, and weigh the carp and other fish. As regards the carp, it is essential to their sale that they should be counted; and even if this was not the case, the counting will be necessary to ascertain how many of the fish originally placed in the pond have been lost, and to find the average weight per fish and per hundred. The noting down of these figures is needed in judging of the quality of a pond. In weighing fish intended for sale it will be best to use scales with two arms.

Spawning pond fisheries.—The spawning pond fisheries should be managed with particular care. The water must not be let off too rapidly, because otherwise the fry is retained in the small holes which form in the mud of the pond, and do not reach the fish-pit, which not only retards the fisheries, but is also apt to injure the little fish. The same care should be exercised in picking up the young fish; and the ma-

* Delius, *Teichwirthschaft*, p. 90.

jority of them should, if possible, be caught in deep water. The fisheries should be carried on as rapidly as possible, so that not too many of the fry perish, and they soon get again in fresh water—in autumn in the winter ponds and in spring in the raising ponds. The spawning carp must be handled just as tenderly as the fry during the fisheries and during their transfer to the raising ponds, as the least injury done to them will hurt not only them but also the fry. Although any injury done to the spawning fish is not as serious after spawning as prior to it (as probably they will be sold immediately or after a short stay in the stock ponds), it is self-evident that, owing to their size and their value, they must be handled with care.

While the fisheries are going on in the spawning ponds, the fry should at once be sorted and arranged in two or three classes. The best way to do this is to put the fry in the sorting-vans covered with linen and to wash them, care being taken that the water does not fall on them too heavily. Experienced men should attend to the sorting, and should place them in the tubs, from which they are taken with nets or dippers, counted, put in the kegs and at once carried to their destination. It should not be omitted to weigh a few of each sort as a test. The necessary hints regarding the transportation of spawning carp have already been given in a former chapter. In these fisheries it is even more necessary than in other fisheries to have a sufficient number of carts on hand (better too many than too few), as the quantity of young fish cannot be calculated beforehand with any degree of certainty. If the fry have to be transported a considerale distance—as will be the case on extensive pond farms—the kegs should be refilled with clear fresh water every two hours; and if this is not found near at hand, one should not hesitate to go out of his way to obtain it. In order not to let the water fall on the fry too heavily, so as to injure or kill them, it should be poured into the kegs through a bunch of straw. The kegs must first be filled with pond water, so as to avoid a too sudden change of temperature which is apt to injure the fry. Care should therefore be taken not to pour in during transportation too much cold water at one time, because this would cool the temperature too rapidly. If the fish are only to be conveyed a short distance, it will not be necessary to add any water.

Raising pond fisheries.—The raising pond fisheries are carried on in the same manner as those in the stock ponds and spawning ponds. In sorting the fish, however, it will be necessary only to distinguish two kinds, small and large ones. To divide the fish into three classes will be necessary only if the pond had originally been stocked with fish varying greatly in size; and this should, if possible, be avoided. A few of each sort should be weighed for a test, which can easily be done in a few minutes. The weight and number of the fish are carefully noted down.

Summer and winter fisheries.—A few remarks must be added regarding the summer and winter fisheries. Both of these fisheries will occur only

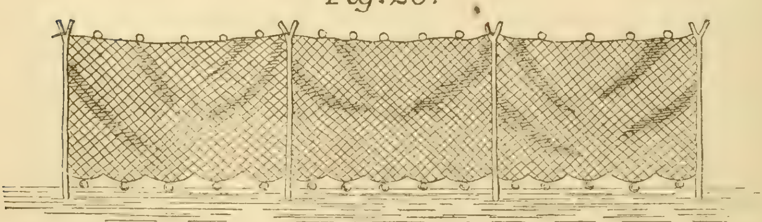
in exceptional cases. Summer fisheries may become necessary, owing to sickness among the fish, or to accommodate an old customer, who pays a higher price, which will, to some extent at least, compensate for the loss in weight. Full compensation cannot be made, as during summer the fish are in their best growth, and as their increase in weight up to autumn does not occasion any special expense. The regular fisheries will, therefore, always occur in autumn, when no further increase in weight is to be looked for. Summer fisheries must be carried on very early in the morning, and if the pond is large they should commence during the night, so that they can be brought to a close before the heat of the day. They generally commence at midnight, when the water has cooled off. In summer fisheries the tubs should be filled with particularly fresh water—if possible, spring or well water. If night fisheries become necessary sufficient light should be furnished by means of torches, for, in spite of all precautions, losses (especially by thieving) can hardly be avoided, particularly in large ponds. These losses will be greater in large ponds than in small ones, and in the stock pond fisheries many pike and especially perch-pike are always lost. The fisheries in small ponds will, as a general rule, pass off without any considerable loss. Under all circumstances, however, night fisheries should only be resorted to in extreme cases.

The same applies to winter fisheries, which should be carried on only in cases of urgent necessity. Unless there is sickness among the fish these will but rarely occur on well-regulated pond farms. Even on such farms winter fisheries may, however, become necessary, if the pond serves industrial purposes, which would suffer from summer fisheries. Winter fisheries are generally carried on about noon; and it will be necessary to remove all the ice from the fish-pit. As in winter fisheries it is impossible to avoid injuries to the fish, they should be sold as soon as possible.

VI.—Fishing Apparatus.

1. The *screen*, or *standing-net*, which is placed before the fish. In large

Fig. 20.

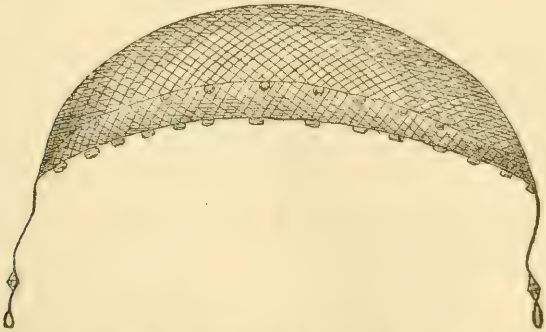


ponds, where the fisheries occupy two to four days, it is preferable to fish in deep water, so that the fish are not covered with mud, or, in warm weather, become languid. The fish are driven by men in boats from the

edges of the pond toward the deep places, and inclosed within the screens the day preceding the fisheries, so as to reduce the fishing area. The meshes of these nets are either large, to allow the small fish to slip through, or they are narrow, so that even small fish cannot pass through.

2. The *seine* is a net of varying size, with wide meshes, and consisting of one or two pieces; along its entire length runs a rope both above and below, the lower one being weighed down with pieces of lead or stones attached to it at intervals of about 30 centimeters, while the upper one has at similar intervals pieces of cork, which keeps the upper part of the net floating in the water while the lower part rests on the bottom. In order to haul the seine to advantage it must be as long as the sheet of water in which the fisheries are to occur, and broad enough to exceed its depth by one-fourth of its breadth, so that it can bulge out and make folds, which is necessary to a successful haul.

Fig. 21.



At each corner of the net a string is fastened, which is made movable by means of a piece of wood. These strings, called arms, are necessary to enable the men to haul the net with a full exertion of all their strength. When the seine is pulled when in the water a large bulging fold is formed in which the fish gather, so the fishermen have only to draw the lower and upper rope together. To clean a pond of fish with this apparatus, it is essential that the bottom where the fisheries are carried on should be even, so that the seine may in its entire length rest on the bottom and that no fish can slip away underneath it. The hauling of the seine will always require several persons, and sometimes a boat. In the latter case the boat is manned by three persons, while three remain on shore and hold on to one arm of the seine. While two of the men in the boat row towards the place where the fishing water begins (as far as the water will carry the boat), the third one lays the seine in the water. As soon as the men in the boat have reached the place where the water begins the men on the shore begin to pull the arms of the seine and drag it on land in a semicircle, while the boat is gradually approaching the shore, the men in it drawing the seine as far towards them and into the boat as is necessary to get the fish together in the trough formed by the

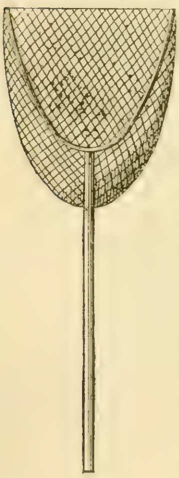
seine. This apparatus is also employed in river fisheries, and should, in that case, occupy the full breadth of the river.

3. The *large seine* is the same kind of net, only on a larger scale. It is used in very large ponds, and for casting and hauling it several boats and often more than twenty men are needed.

4. The *single seine* is a small net of the same kind. Both of its ends are tied to poles and are hauled, while the upper part of the net floats on the water. As nets represent considerable capital, it is desirable that they should last as long as possible. The best and simplest means to attain this end is to lay them in a tan-pit until they have assumed a brownish color, which, if they are tolerably moist, will take place in about forty-eight hours.

5. The *purse-net* consists of a handle, 75 to 125 centimeters long, ending like a fork in two prongs, each 50 centimeters long, between which a round or square net is extended. The handle must be strong enough not to bend or break by the weight of the fish. The net should be well made and be strong so as not to become enlarged by constant use, which would render it difficult to empty out the fish. According to the kind of fish which are to be caught, the meshes will have to vary in size. This apparatus is used for taking fish from the seine, or, in small ponds, for catching the fish in the water. It may also be used for taking fish from tanks, tubs, or ditches.

Fig. 22.



6. The *fish-dipper* is a sort of purse-net. It consists of a bag-shaped net tied to a wooden or iron hoop, to which is fastened a handle measuring about one meter in length. It is used for taking fish from the seine or from tubs.

7. For *pike* and *perch-pike* purse nets are used, consisting of a two-pronged fork, each prong measuring 50 to 80 centimeters in length, with a handle 2 to 2.5 meters long. The net is fastened to and extends between these two prongs, and is shaped more like a trough than a bag, being longer and shallower than the purse-net. With this apparatus pike and perch-pike are taken out singly and immediately transferred to fresh water.

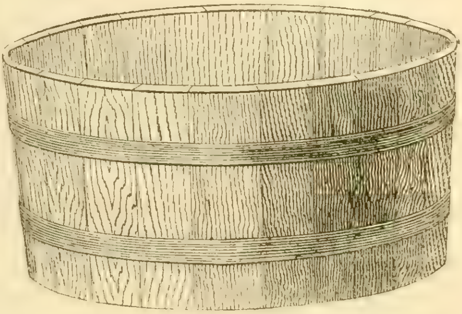
Fig. 23.

The purse-net used for eels has very narrow meshes and forms a deep bag, so that these slippery fish cannot easily escape.

Fig. 24.

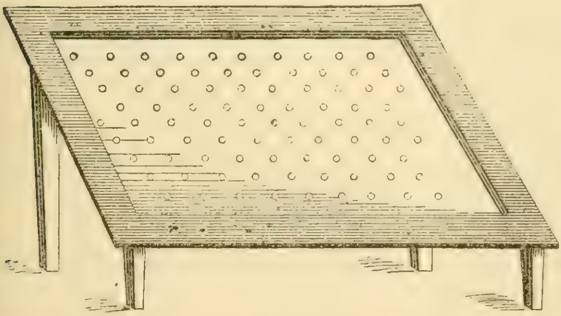
8. The *sorting-tubs.*—These must be made of pine wood, and have at the top a diameter of 1 meter; they should be 50 centimeters high, so that they can easily hold 3 to 4 hectoliters of water. The diameter at the bottom should be a little smaller than at the top, just enough to keep the staves in position.

Fig. 25.



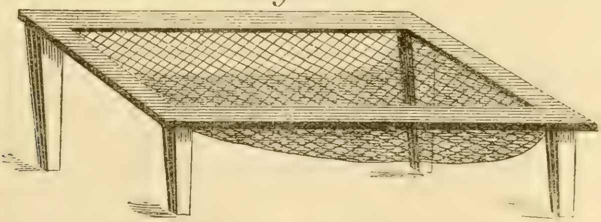
9. *Sorting-tables.*—The sorting-table consists of a large leaf perforated in many places, with a raised edge, about 20 centimeters high. It should be large enough to hold 300 to 400 pounds of fish. As a general rule it is 1.7 to 2 meters long, and 1 meter broad. Directions as to the manner of using these tables have been given in a previous chapter.

Fig. 26.



Sometimes sorting-tables are used, which, instead of the perforated leaf, have a net drawn tight and firmly fastened to a square frame measuring about 10 centimeters in breadth. The meshes of this net are very wide, so that the small fish fall through into another net with narrow meshes extended below the first, and are thus separated from the large ones. If the sorting-table has the dimensions given above, it is well adapted to its purpose, but if it is only 60 centimeters long and

Fig. 27.

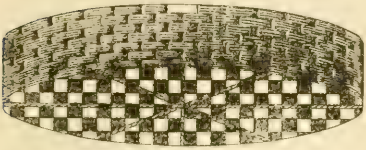


broad, it does not fulfil its object. In tables of these dimensions the net cannot be drawn tight enough; the fish which fall on it are placed in unnatural positions, and it becomes impossible to sort them at a glance as the business requires, as a few fish will completely fill such a small table.

10. *Sorting-vans.*—These are the most practical apparatus for sorting fish. They have been in use for some time on the Wittingau pond farm, and from my own experience I can testify as to their usefulness.

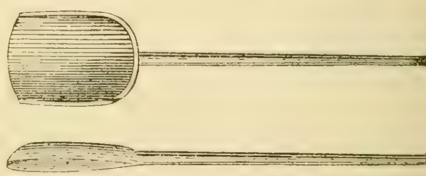
In this apparatus the fish lie stretched out full length, and an experienced person will be able to sort them without much loss of time. In their shape these vans resemble those which are used for winnowing grain. They are very firmly plaited of willow bands, and the bottom has numerous openings of a square centimeter each. To protect the bottom thick ropes are drawn below it in the shape of a star. These vans measure 70 centimeters in diameter and 20 centimeters in height. Each van is placed between two tubs, its bottom resting on the edges; the fish are placed in them, washed and sorted and put in the tubs.

Fig. 28.



11. *Water-dippers.*—These are small wooden shovels, made of a single piece of wood. The handle is about 70 to 75 centimeters long, and the shovel, somewhat resembling a trough, is 30 centimeters long, 20 centimeters broad, and 10 centimeters deep in the middle. These dippers are used for filling the tubs with water; and several men are employed in throwing the water by means of these dippers from the fish-pit into the tubs, in which manner they are filled very rapidly. They are also used for pouring water on the fish for the purpose of cleaning them while in the sorting-vans and for occasionally stirring the water in the tubs, to keep the fish in motion, and to further the absorption of oxygen by the water. They also prove useful in many other ways.

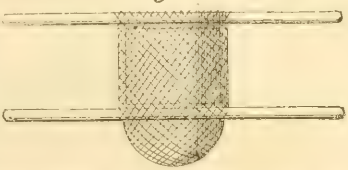
Fig. 29.



12. *Tubs and baskets.*—These are used for transporting the fish, if the fish-pit is not near the dike; and also if there are holes in the bottom of the pond, as is frequently the case in large ponds, which makes the distance to the tubs too great to carry the fish in purse-nets. If the fish are to be taken to ponds or winter ponds which are close at hand, kegs may be dispensed with, and baskets or tubs used instead. Both baskets and tubs are oval-shaped, the former of coarse wicker-work, and the latter of pine wood. Special care should be taken that no sharp points project on the inside of these baskets. These baskets and tubs are of different size. The most suitable dimensions are 70 centimeters in length, 40 in breadth, and 30 to 40 in height. The tubs for transporting single fish, *e. g.*, perch-pike, resemble in shape and size the small bath-tubs used for washing babies. On some pond farms they are used instead of tubs and baskets.

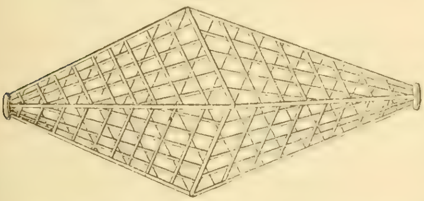
13. *Net-barrows.*—This implement consists of a bag-shaped net which can hold about 100 pounds of fish, and which is held in position by two long and two short poles. The long poles enable two persons to carry it. My experience has taught me to condemn the use of this implement, as the fish are kept in an unnatural position and press too heavily against each other. The lower ones will suffer most, as they are pressed against the net, frequently lose scales, and are seriously injured.

Fig.30.



14. *Fish-cloths.*—These are large pieces of coarse linen cloth, about 1 meter long and broad, intended to convey the fish from the tubs to the kegs. They are exceedingly practical for this purpose, and may be substituted for baskets and tubs. There is no fear that the fish will be injured in them, and they are quite inexpensive.

Fig.31.



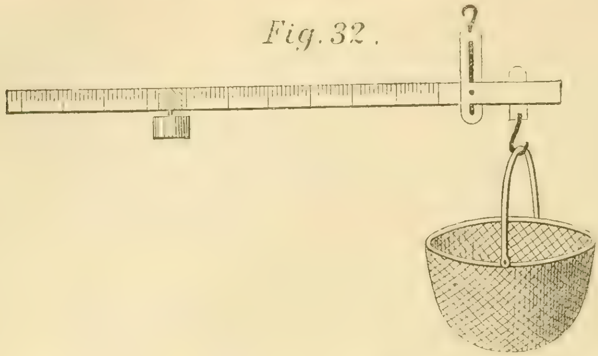
15. The *tap-basket.*—As soon as the tap has been drawn, this basket is placed in the opening. It is made of coarse wicker-work, the openings varying in size with the size of the fish, and has the shape of two obtuse pyramids, joined at the base.

16. The *great fish scales.*—For weighing carp intended for the market the scales used on the Wittingau pond farm appear to me to be the most practical, and I shall, therefore, give a short description of them. There is a frame-work, constructed of stout pieces of wood, which ends in a sort of gallows, between whose arms there is a shelf for the weights, &c. From the cross-beam is suspended a pair of scales, on one side a scale for receiving the weights, and on the other a shallow wooden tub held together with iron rims for receiving the fish. The length of this tub is 70 centimeters, and its breadth and depth 40. The sides have four rows of small holes, measuring about 2 centimeters, so that the water can flow off. Such a tub holds a little above 100 pounds. As this is the quantity weighed each time, the weighing proceeds very rapidly, and 10,000 pounds of carp can easily be weighed in one hour.

17. The *small scales.*—This consists of a long iron arm or pole, at the one end of which a basket hangs in a hook, while from the longer part of the arm the weight is suspended, which is moved backwards and forwards until the equilibrium is restored. The weight can then be read off from the marks on the long pole. In order to avoid the deducting of the weight of the basket each time fish are weighed, it may be well, when the scales are gauged, to take into account the weight of the basket in a moist condition. These scales are used for taking test weights in the spawning pond and raising pond fisheries, or if a few

fish are to be sold at the dike. For the purpose of weighing fish with these scales, two men as near of a size as possible lay one of the water-

Fig. 32.

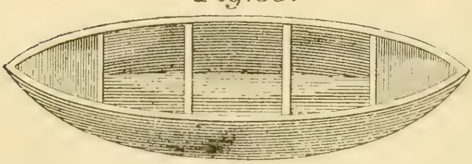


dippers described above over their shoulders; the scales are suspended between the two men from the handle of the dipper, and weighing begins.

18. *Fishermen's clothes.*—Of special articles of clothing we will only mention large leather boots reaching above the thighs; and to these may be added, in very large ponds, a leather jacket buttoned to these boots.

19. *Boats.*—There should be on hand a suitable number of flat-bottomed boats, which by boards placed crosswise are divided into several compartments, so that if necessary fish can be stored away in them.

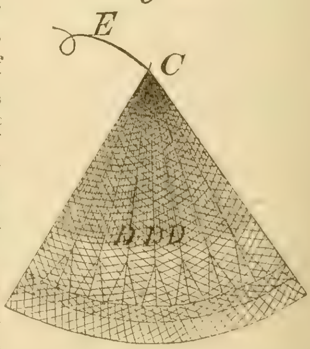
Fig. 33.



20. In *river fisheries* some other nets and seines are used in addition to those described. These are:

(*a*) The *cast-net*, described by Molin, as follows: The cast-net is cone-shaped, its mouth is very wide and must be proportioned to the height. At the point C, a rope, E, varying in length, is fastened. If a net of this kind measures 20 meters in breadth, it should be 4 meters high. As a general rule the proportion of its height to its breadth is as 1 to 5. The edge of the mouth is hemmed with a rope of the thickness of a quill, from which depend lead balls, weighing 30 grams each, which are placed at equal distances from each other, and weigh 10 to 12 kilograms in all. The edge of the net projects beyond this rope about 22 to 33 centimeters, but is folded inside and fastened in some places to the lines D D D, which extend from the top to the edge, so that the edge folded inside forms a series of pockets round the mouth of the net,

Fig. 34.



in which the fish become entangled. The meshes of the net decrease in size from the point towards the edge, being about 6 centimeters wide near the point, and so narrow near the edge that a finger can hardly be pushed through. Large nets of this kind are drawn and small ones are cast. In the water it opens out like an umbrella, and when taken out it is twisted so as to inclose the fish securely. It can be used only where the bottom is free from aquatic plants and other impediments.

(*b*) The *dip-net*.—This is a square net, whose sides are 1 to 2 meters long, and which is fastened to a strong rope. The meshes get narrower

Fig. 35.

towards the bottom, so that the small fish, which go towards the bottom, cannot fall through. The four corners of the net are fastened to two hoops placed crosswise, which serve to keep it extended. At the place where the hoops cross each other it is, by means of a rope, fastened to a pole 5 to 7 meters long. When fish are to be caught with this net a bait is placed in it and it is dipped into the water.

(*c*) The *hose-net*.—This apparatus consists of a net 10 to 12 meters long, which is very wide at the top and, gradually getting narrower, ends in a pointed bag. This net is only used in very narrow rivers, where it covers the entire breadth of water. The fish enter through the wide opening and go up into the narrow portion of the net, whence they cannot retrace their way, but where they are frequently crushed to death. To remedy this evil,

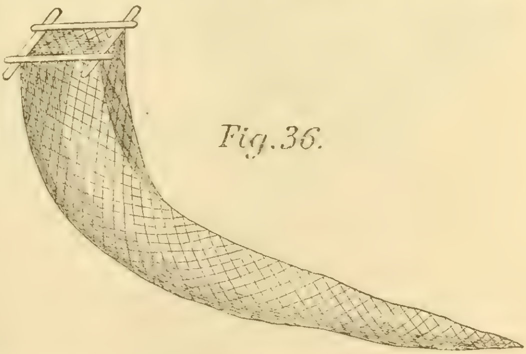
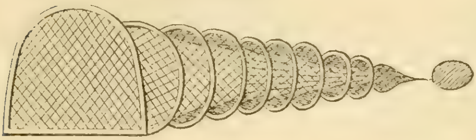


Fig. 36.

(*d*) The *bag-net* has been constructed, which in its use closely resembles the hose-net. It differs from this net by the fact that the bag is kept extended by hoops. At the mouth a very large hoop is fastened, and at certain intervals hoops follow each other, which gradually become narrower, and keep the net extended, so the fish can move about in it.

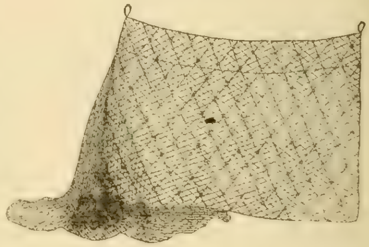
To each hoop nets are attached, not longer than the distance from one hoop to the other, and shaped like a funnel, their wide upper opening being fastened to the hoop and the lower narrower one floating freely in the bag. The fish enter through the mouth of the bag, pass from one net to the other, and cannot get out again.

Fig. 37.



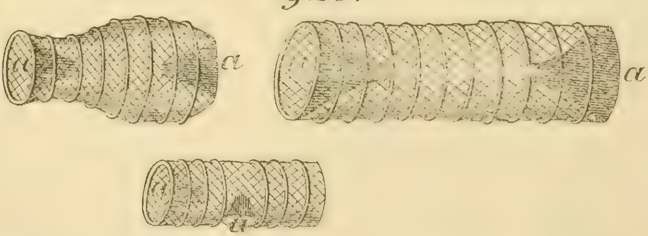
(*e*) The *threefold net.*—This consists of three nets placed one over the other. The two outer nets have very wide meshes (about 15 to 30 centimeters). The inside net is twice as large as the outer ones, and the size of its meshes varies from 5 to 7 centimeters, according to the kind of fish which are to be caught. These nets are used where the banks are covered with a dense growth of shrubs and aquatic plants. They are weighted by pieces of lead attached to the bottom, placed in the water, and the fish are driven towards them, become entangled, and can easily be caught.

Fig. 38.



(*f*) *Fish-pots.*—These are a kind of baskets made of wicker-work, and varying in size, long, round, barrel-shaped, &c. The width of the openings in the wicker-work depends on the size of the fish which are to be caught. These openings, however, must never be so narrow as to prevent the water from flowing through. These fish-pots have one or

Fig. 39.



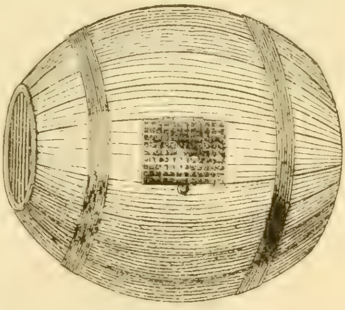
more funnel-shaped entrances, *a*, which are constructed of willow branches from which the bark has been removed. The wide opening of the funnel is toward the outside and the narrow one toward the inside of the fish-pot. When the fish enters through these funnels, the willow branches give way, but close again after the fish has passed through, so that it cannot escape. For large fish, and especially for eels, these fish-pots must be made very strong, as they use great force in their endeavors to get out.

(*g*) The *night-line or bottom-line.*—This is a long line, to which are fastened several hundred hooks, attached to horse-hair lines 60 centimeters

long, and placed at intervals of 1.75 to 2 meters. To these hooks bait is fastened. It may be of any desired length according to the area of the sheet of water where it is to be used. By means of large stones, weighing 15 to 20 pounds each, it is sunk to the bottom close to the shore, and retained there by these stones and by smaller ones, one of which is fastened to the line between every two hooks. This line is set in the evening and lifted from the water in the morning by means of a strong iron hook.

21. The *fish-kegs* should not be very large, but capable of holding about 5 hectoliters of water, so that, according to the temperature, they can hold from 200 to 400 pounds of fish. The inside must be perfectly smooth, and should not have a bung stopper, however short, so that the fish cannot be injured by any uneven places on the inside. At the top these kegs should have in the center a hole large enough to admit the largest fish. The hole should be covered with a perforated tin lid or with a lid made of wicker-work. On some farms it is the custom, after the fish have been put in the keg, merely to stop up the hole with a large bunch of straw. The kegs are generally of a long shape. Small kegs, flattened at the end, capable of holding about 100 pounds of fish, are more serviceable than round kegs, and are to be specially recommended if fish are to be transported any great distance. In such kegs the fish are not piled up one on the top of the other, but can lie comfortably side by side, Such oval kegs generally measure 87.5 centimeters in length, the same in breadth, and 22 centimeters in height. The bunghole is very wide, and can be closed with a grate-lid and locked with a padlock. To the sides two rings are generally attached, so that two men can conveniently carry it. But, as these kegs do not afford absolute security for the transportation of tender kinds of fish—as perch-pike, pike, and trout—to any considerable distance, even if a piece of ice is thrown into it or fastened to the bung-hole in such a manner as to allow the water to drip from it into the keg, self-acting fish-wagons have been constructed, in which air is introduced into the water of the kegs by means of a pair of bellows kept in motion by the action of the wheels.

Fig. 40.



For transporting trout by railroad Mr. Jean Richard, of Lorraine, in 1876 constructed an apparatus which renews the air of the water during transportation in the same manner in which this object is attained in nature by the rushing of mountain streams over rocks and stones. This apparatus consists of a tin box, which is divided in two compartments by a perforated piece of tin. Both compartments are only half filled with water. The trout are placed in one, while in the other there

is a sort of a mill-wheel, which is set in motion by clock-work which is wound up. In this manner the water is brought in constant contact with fresh air, and the trout travel by rail under the same conditions as in the mountain streams of their homes.*

VII.—Pond fisheries at Wittingau.

To give an idea of the manner in which pond fisheries are conducted, and of the work connected therewith, I shall describe the fisheries in one of the Wittingau ponds in Bohemia, having an area of 320 hectares, which I witnessed in October, 1877; the practical manner in which these fisheries were conducted impressed me so strongly, that I immediately followed this example and procured all the necessary apparatus for my own fisheries. I have never regretted the expense, for fishing with this apparatus proved exceedingly practical even in small ponds. The fisheries were brought to a close much sooner than formerly, and the fish were treated in a much more humane manner. I prefer to give a description of the fisheries in one of the Wittingau ponds, instead of one of my own ponds, because my largest pond only measured about 50 hectares, while many of my readers doubtless own ponds of much larger extent, and will probably be more interested in the description of the fisheries in a large pond. It is, moreover, easier to adapt the methods followed in a large pond to a small one than to reverse this.

The pond in question, owing to its great size, took a long time to drain, and towards the end of this process it had to be watched by day and night. For sheltering the necessary number of fishermen an exceedingly practical and simple shed had been built on the enormous stone dike. A square is marked off, and at each corner strong posts are driven in the ground. These posts are about 2 meters high, and are at the top connected by strong cross-beams. Along the four sides of this scaffolding long poles (stout hop-poles) are placed close to each other, leaving an opening at the top to let the smoke out. The spaces between the poles are so closely stopped up with reeds that neither wind nor rain can enter. On the inner side of the shed bunks are constructed, by driving a number of short posts into the ground close to each other, which are connected at the top by beams, and on which boards are placed, which are covered with a thick layer of reeds; a blanket serves as a cover, and in this manner a very comfortable bed

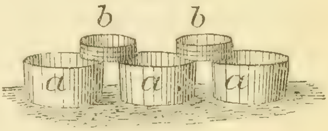
Fig. 41.

* *Mittheilungen ueber Fischerei-Wesen* (organ of the Bavarian Fishery Association), 1876, No. 5.

is provided. This shed, which has a narrow door in front, and in the center of which an open fire is lighted, can accommodate about 20 men.

Below the dike, next to the fish-pit, a shed had been erected for the officials and the buyers of fish. It was a simple frame building with windows, in one corner a small iron stove, and in the center a table and some chairs. A shed like this one, which can easily be put up and taken down, is erected only near the stock ponds, while there is a fisherman's shed near every pond which has to be watched continuously for one or several days: the size of this shed will depend on the size of the pond, and the number of people which it requires to watch it. At the small ponds where no fishermen's sheds are needed, an immense umbrella is used, which protects the official who keeps the books against wind and rain, a small table and chair being placed underneath. This simple apparatus, which proves an admirable shelter, cannot be too strongly recommended. After this digression we will return to our pond. The entire ground bordering the fish-pit as far as the edge of the sole of the dike, and thence along the scarp up to the crest, is covered thickly with reeds, so that there is a dry walk to the fish-pit, and that the fish which accidentally fall to the ground may not be injured. Along the fish-pit, close to the water, there are placed twenty tubs of the kind described above, filled with pure water. On the tubs in the center, *a a a*, some sorting-vans are placed, *b b*, on the edges of two adjoining tubs. On the dike there are from sixty to seventy carts, each loaded with two kegs filled with water.

Fig. 42.



About fifty fishermen, clad almost entirely in leather, stand ready to engage in the fisheries, commanded by a fishing master and an assistant. The water has been let off so that in the fish-pit it has a depth of about 1 meter.

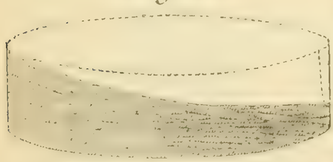
The fisheries commence by some of the fishermen (about twenty) entering the pond, carrying a net about 1 meter broad, and each provided with sticks about 1½ meters long, and ending in a natural two-pronged fork. Every 4 meters a man holds the upper part of the net, the lower part weighted with lead balls resting on the ground.

While the fishermen hold the net in a vertical position they proceed towards the fish-pit, and by beating the water with their sticks drive the fish towards the pit. As soon as this has been reached the sticks are driven into the ground and the top of the net fastened to the prongs, so that the fish-pit is entirely inclosed, and no fish can escape. The length of the net must, of course, correspond to the water area; in the present case it was probably 80 to 100 meters. This driving of the fish is a difficult matter, as the men have to wade in deep mud, and is, especially in large ponds, done in the early morning hours of the day preceding the fisheries. It offers the advantage of fishing within a small area and in deep water. After the fish have been driven into the fish-

pit, nine to ten flat-boats, each containing two men, are rowed into the pond. The middle boat contains the fishing master, who directs operations. From these boats the large seine is cast and is drawn towards the shore by ten men, while the boats gradually approach the fish-pit in a semicircle, constantly growing narrower, and whose diameter is the length of the fish-pit along the shore, so that the fish are finally entirely inclosed in the seine. As soon as this is accomplished the fish are taken from the seine. While some men catch the tender perch-pike singly with the hands in sorting-vans held floating on the water, others carry them to the kegs in tubs; other men, armed with purse-nets and dip-nets, catch the carp, occasionally mixed with pike, and carry them to the tubs, from which they are sorted and weighed. As the taking of the fish from the seine is, of course, a much more rapid process than the sorting and weighing, the fish are first put in the outer row of tubs and thence in the middle row, where they are sorted. For sorting the fish are taken from the tubs with purse-nets—if possible direct from the ponds—and placed on the sorting-vans, where fresh water is poured over them several times by a man specially engaged for that purpose, whereupon they are sorted in the tubs to the right and left, whence they are taken to the scales. It is of course understood that in a pond as large as the one in question several persons are engaged in sorting. As long as the fish are in the tubs, water is continually poured over them with the water-dippers, and they are occasionally stirred carefully with the same instruments, so that the same fish are not kept at the bottom all the time, and also for the purpose of continually introducing fresh air into the water.

Close to the scales there is placed a tub of the same size as the sorting-tubs, the interior and sides of which are thickly covered with reeds, over which a piece of linen is spread. These reeds are arranged in such a way as to form in the tub an inclined plane, whose highest point is on the side near the scales. When the fish are quickly taken from the scales they gently slide down into the hands of the persons counting them, and there is very little chance of their being hurt. Two men stand near this tub and count the fish into a large piece of cloth held up by two women, each holding two of the four corners. After 12 fish (or, if they are not very large, 15) have been counted, each woman twists her two corners together and hands the cloth to the next two women, of whom a double row extends all along the scarp of the dike. Thus the fish pass from hand to hand until they reach the keg. Here they are received by two men standing on the wagon. The one twisted end of the cloth is stuck into the opening of the keg, and the other lifted up, so the fish glide slowly into the keg without touching the edges of the hole. As soon as one cloth has been emptied into

Fig 43.



the keg it is returned to the scales the same way it came, so as to have a constant supply of these cloths on hand and not to interrupt the weighing and counting. After the two kegs contained in a wagon have each received 200 to 300 pounds of carp (in cool weather 400 pounds may safely be put in one keg) the wagon drives away and another takes its place, and thus it goes on until the end is reached. The weighing is conducted by the assistant fishing master, who, with a loud voice, calls out every hundred-weight. (Buyers get from 2 to 5 per cent additional fish, to make up for the water remaining in the tub.) The counting into the cloths is likewise done in a loud voice, and the number contained in each cloth is called out very distinctly. Near the fish-pit stands the comptroller, who puts down every hundredweight and the quantity contained in each cloth. Near the wagons stands another comptroller, who notes down the number of fish emptied into the kegs from each cloth, the number of hundred-weights called out, the name of the driver, and the fish-dealer, or the name of the pond to which the fish are taken. In this manner it becomes almost impossible to make a mistake, which at any rate would soon be discovered.

While this work is going on, another squad of the fishermen make another large haul—the first one in this case yielded 50,000 pounds—and the fish which, after the seine fisheries have been brought to a close, still remain in the pond, are gathered with purse-nets and dip-nets.

The meshes of the seines and of the purse-nets are 3 centimeters wide from knot to knot, but are preferable to narrower meshes, because these bring up too much mud, while in the nets with large meshes the fish come out of the pond much cleaner. The only disadvantage is that many small pike stick in the meshes with their gills and perish, but as a general rule their number is such that the loss is amply compensated by the advantages which these nets offer to the carp and other fish.

The small pike are immediately transferred to the carp stock ponds. The perch-pike, which is a very tender fish, should be handled as carefully as possible; they are carried in tubs to the kegs, in which they are put one by one, a limited number only being assigned to each keg. The large pike which have not been sold on the spot are temporarily placed in fish-tanks. The same applies to the tench, some of which, however, are immediately transferred to the carp ponds. Large fish of other less valuable kinds, as well as carp which have suffered injuries, are gathered in a separate tub, and are given to the day laborers assisting in the fisheries, instead of paying them money, most of them preferring this way of being paid. Small fish of inferior kinds are transferred to special tanks and serve as pike food.

The fisheries in the Zablat pond, belonging to the Wittingau farm, began at 6 o'clock in the morning and were finished at noon, the total yield amounting to 69,000 pounds of carp, 1,800 pounds pike, 800 pounds perch-pike, 3,000 small pike, 840 perch, and 540 tench (the latter weighing about 400 pounds).

The carp fisheries in small stock ponds differ from those described above merely by the circumstance that they are often carried on with only one boat and a seine, and by employing fewer tubs and other apparatus and a smaller number of men. As for the rest, the method pursued is exactly the same. The number of persons and the quantity of apparatus needed should, however, not be calculated according to the proportion of the yield expected to the quantity of apparatus, &c., used for a certain given yield, *i. e.*, one should not calculate in the following manner: If for fishing a pond area of 300 hectares, or the taking of 70,000 pounds of fish, I need 20 tubs or 50 fishermen, &c., I will for an expected yield of 10,000 pounds need one-seventh the number of tubs and fishermen. In the latter case, not 3 but 15 tubs will be needed to expedite business, viz., one for the large pike, one for the small pike, two for sorting the tench, one for inferior kinds of fish, one for other fish which are to be sorted, and nine for the carp. Two to three men should be employed in sorting the fish, and two for cleaning them and for renewing the water in the tubs. For the fisheries proper 20 persons will not be too many, and to these should be added a number of women, corresponding to the distance between the fish-pit and the kegs. The number of wagons will be determined by the quantity of fish put in each keg, and by the distance which these wagons have to travel; also by the circumstance whether these wagons can return to the ponds before the fisheries are over and thus take another load, or whether one trip is all they can accomplish. In the latter case, and counting 400 pounds of fish per keg—therefore 800 per wagon—an expected yield of 10,000 pounds would require 13 wagons, or, better still, a few more, as the yield can never be accurately calculated beforehand. If a wagon can make two or three trips, only one-half or one-third the number of wagons is required. The quantity of apparatus and the number of wagons and men needed for one pond can only be determined with any degree of accuracy after fisheries have taken place in it once.

In the raising pond fisheries the weighing process is dispensed with, and no tubs are needed for inferior kinds of fish. The number of tubs will, therefore, be determined by the quantity of fish with which the pond was stocked. Allowing for their being assorted in two or three classes, comparatively few tubs will be needed, and for a small pond two to three will often suffice. It will be well, however, always to have in readiness an extra tub for inferior fish. As regards the weighing, it will be sufficient to weight 100 of each class in two or four divisions, and on this basis to calculate the average weight of the entire class. This weighing will consume but very little time. The same applies to spawning ponds. Care should, however, be taken to have on hand the required dip-nets or other measures for ascertaining the quantity of fry and to have the sorting-vans covered with linen cloth.

VIII.—The Sale of Fish.

Regarding the methods pursued at the carp exchange at Cottbus. province of Brandenburg, Prussia, I quote from a report by Mr. von Treskow-Weissagk:* "As a general rule the fish which are sold are delivered at the nearest railroad station at the expense of the seller. As soon as the fish are weighed they belong to the buyer, who has to bear all further risk. Many pond owners have tanks to which the carp are transferred from the ponds, and whence they are taken by the fish-dealers as they need them. In some places the fish are weighed at the pond, and the buyer places them in the tanks, taking all the risk of loss of weight, while in other places the fish are not weighed until they leave the tank. As this is not done till near Christmas, fish sold on this condition fetch a higher price than those delivered from the ponds in autumn. The fish are conveyed to the cities in fish-tanks resembling boats, and of late years by railroad."

On the pond farm which I formerly managed, the fish were only sold wholesale for cash, and delivered to the buyer at the pond, he furnishing the wagons to take them away. Immediately after the fish had been weighed they became the property of the buyer, he taking all the risks. On the largest pond farm in Bohemia—probably the largest in the world—the fish are (according to Mr. Horak's report) sold only for cash, and delivered to the buyers at the dike; and only in rare cases buyers are allowed to take the fish away by simply paying a portion of the money. The minute the fish leave the scales they become the property of the buyer. If the buyers desire it, wagons are furnished them by the authorities of the pond farm; the expenses, however, are borne by the buyers, who are also held responsible for any expenses incurred in supervising the transportation of the fish. Those fish-dealers who do not immediately carry away the fish which they have bought, but temporarily place them in tanks on the pond farm, must also, as a general rule, pay cash, or at least part in cash. The transportation from the pond to the tanks, and the keeping of the fish in the tanks, is at their risk. From these tanks, which are kept under special supervision, the fish-dealers can take fish at any time and in any desired quantity by simply giving a written order. Dead fish discovered by the persons intrusted with the supervision of these tanks must be shown to the authorities of the pond farm; whereupon they are dried and kept for the purpose of showing them to the fish-dealer whenever a suitable opportunity offers. As soon as this has been done their heads are cut off, to prevent any possible abuse.

IX.—The Transportation of Fish.

Fish are either transported from one pond to the other, or to winter ponds and tanks, or to some distance, if they have been sold. In the

* *Deutsche Fischerei-Zeitung*, 1878, p. 195.

first case, the conditions being the same (as to the size of the keg, the temperature, &c.), more fish can be put in a keg than in the latter case.

In kegs filled with water.—The kegs intended for transporting fish should be carefully examined, to see whether they have any rough places or holes where the water might flow out, and should undergo a thorough cleaning. New kegs should be filled with water and allowed to stand for some time before they are used; and fish should not be put in them until the smell of the wood has entirely left them, as it is apt to stupefy the fish. For filling the kegs, pond, river, or brook water is used; they are filled only one-half, whereupon the fish (carp) are put in carefully one by one, so as to avoid their rubbing against the edges of the hole. If the fish are emptied into the kegs from a cloth, they should also be allowed to glide in one by one. If pike are to be transported, it will be well to put them in the keg singly, and tail foremost, so as not to run the risk of hurting their tender snout by bumping against the sides of the keg. After the keg has received its quota of fish, an empty space of about 10 centimeters should remain between the bunghole and the water, so as to give a moderate motion to the water, which is necessary, as the gills of the carp when in the keg are apt to be closed up by a sticky slime, in consequence of which they fall into a death-like slumber, from which they must be roused. Whenever there is a stoppage on the journey, the kegs should be shaken, which will also furnish fresh air to the water. The water may also occasionally be stirred carefully with a stick. The water in the keg should always be kept at the same height. The same applies to the transportation of tench, crucians, and eels. If fish with prickly fins, such as perch-pike, perch, &c., are to be transported, the keg must be entirely filled with water to prevent the fish from hurting each other when thrown about by the rocking motion of the water. Whenever an opportunity offers, water must be put into the keg during the journey. After the keg has received its quota of fish, the bung-hole is closed with a wire grate, or a perforated tin lid, or even with a lid made of wicker-work. Occasionally the opening is simply stopped up with a bunch of straw. This latter method, however, cannot be recommended, as, in order to stick firmly, the bunch of straw must be pushed into the keg to the depth of several centimeters, so that the fish are easily injured, especially in their scales and eyes, by pushing against the sharp points of the straw. A wagon may hold two to three kegs, each containing 5 or 6 hectoliters of water. The kegs are generally placed on the wagon lengthwise; for long distances, however, this position is not favorable, as the waves (caused by the motion of the wagon) will move in the direction in which the wagon goes, and will, therefore, hurl the fish against the bottom of the keg, so that, if the journey is long, or if the wagon is driven very rapidly, the fish may be killed. Slow driving should, therefore, be the rule, and the kegs should rest on a thick bed of straw to avoid the rocking motion of the water as much as possible.

Wherever it is practicable the kegs should be laid on the wagon crosswise; and the waves, also following the motion of the wagon, will generally move in a circle along the sides of the keg. The fish which follow this motion do, therefore, not come in such violent contact with the sides of the keg as to be hurt. This manner of placing the kegs should, therefore, be adopted in all cases where fish are to be transported a long distance, but may also be recommended for short journeys. In transporting carp and tench short distances, *e. g.*, from one pond to the other, on cool spring or autumn days, the following quantity of fish may be put in a keg:

Age.	Holding 1 hectoliter.	Holding 5 hectoliters.
Fry	400 to 500	2,000 to 2,500
Small two years' fish	100	500
Medium-sized two years' fish	80	400
Large two years' fish	50	250
Three years' fish	45	220
Four years' fish	25	120

On warm days the number should be smaller. In transporting pike, perch-pike, and trout, one-fourth less should be counted.

If fish are to be transported several days' journeys, they should be prepared for this transportation, *i. e.*, they should not be taken direct from the pond, when they are generally covered with mud, but be placed in tanks containing pure water for several days, so that their gills may be thoroughly cleaned from any mud which may adhere to them. During that time they should not receive any food, so that they can be placed in the kegs with an empty stomach. The rocking motion will then not cause them to throw up and pollute the water, which in that condition is apt to paste the gills together. Prepared in this manner, and if the kegs are not overcrowded, even tender fish can be transported safely a considerable distance. For long journeys a keg holding 5 hectoliters of water should never contain more than 100 pounds of fish, and only in very cool weather 200 pounds of carp, while of tender fish, such as perch-pike, trout, pike, &c., 70 pounds is the utmost limit. Different kinds of fish, especially fish of prey and other fish, should never be transported in one and the same keg.

During long journeys the keg should be refilled with fresh water at least every eight hours. Spring or well water will be the best for this purpose. If it is possible, cool days should be selected for transporting fish any considerable distance; the cooler the weather the better for the fish. If the transportation occupies several days, the fish must be taken out of the kegs during the night and placed in tanks, so that they may enjoy some rest and be prepared for the fatigue of the following day. If the fish can be transported by water in perforated boxes attached to rafts or boats, this is, of course, the safest method. In that case a large number of fish may be put in one box. In transporting

fish during the warm season, it may be recommended to throw a piece of ice into the keg or lay it on the lid of the bung-hole. Kegs have been constructed where the ice is kept in a separate box attached to the bottom of the keg. For long distances those means of transportation are the most suitable where a self-acting apparatus introduces air into the water. If the fish have been prepared for the journey in the manner described above, if the kegs are not crowded too much, and if they are placed on the wagon crosswise, even very tender fish can be transported safely several days' journey. The kegs should not be more than 1 meter long, and if possible be obtuse at the ends, so that the fish can lie side by side and not one on the top of the other.

Without water.—Tscheiner teaches different methods of sending carp dry, which should be mentioned here, as there may be cases where this method of transportation will be more advantageous than that in kegs, for instance, where the market is near, or if there is a lack of kegs. Tscheiner says:* "If the carp are to be transported dry, it is above everything else necessary to clean them well from all mud, which is best done in some small shallow pond. After the carp have been cleaned a cart is brought which has strong boards on all four sides, and a thick layer of straw on the bottom. Hay kills the fish. To the front part of the cart plaits of straw should be attached, but not too firmly, so the fish can get enough air. After the cart has been prepared, a number of carp are taken up with a purse-net and placed in the cart in the following manner: The first carp is put in the straw, back downward, close to the straw plait, so that its head rests on it. The head and tail are kept in position by fresh, moist moss, and a few stalks of straw made tough by water are pulled from the bottom of the cart and laid crosswise over the fish. Another nest is made in the straw, in which the second carp is laid close to the first; moss is placed between the fish, and stalks of straw laid over them. In this way the row is continued to the end. The second row is commenced by placing the head of the first fish between the tails of the two last fish of the first row. Care should be taken that the fish in the second row are not hurt by the movements of the tails of those in the first row. This process is continued until the bottom of the cart is completely covered. As soon as a cart has received its load it should start immediately, prior to which, however, the fish must be covered with a thin layer of straw and a wet cloth. This must not delay the starting of the cart, because rest is injurious to the fish when packed in this manner, while motion is very beneficial to them. If the load of the cart is to be increased by one or two rows, the carp must be placed in another way. They are laid on the stomach, because when placed on the back the weight of the upper rows would press too hard on the stomach of the lower ones, while when laid on the stomach the hard back resists the pressure which is brought to bear upon it. As the back of the carp is

*Tscheiner, *Der wohlerfahrene Fischmeister*, 1821.

raised, the fish of the upper rows are placed in such a manner that every fish rests against the front part of the backs of two carp of the lower row. No more than three rows should ever be placed in a cart, and a thick layer of straw should be put between every two rows. For drawing these carts horses are better than donkeys or mules, because they will accomplish the journey in the shortest possible time. South wind, which is injurious to fish when transported in this manner, should be carefully avoided.

"If the place of destination can be reached in six or seven hours, the journey can be continued without interruption; but if the distance is greater, a halt should be made every evening in some place where there is pure river or spring water. The cart is driven to the water, the back straw plait is loosened, the horses are unhitched, and the fish are placed in the water, which should not be deeper than from 9 to 12 centimeters. Through the rapid motion the carp are roused from their torpor, and as soon as they feel the water, they endeavor to get into their natural position. If some of them remain lying on the side, one should blow into their gill openings, place them on the edge of the water, and hold them for a few moments in their natural position. After all the carp which compose the load have somewhat recuperated, it will be advisable to place them, if possible, in a second tank some time during the night. This tank should be at least 25 to 37 centimeters deep, and be filled with pure water. The next morning the fish are packed in the wagon as on the day previous, and thus the journey is continued, until the fish arrive at their destination. Fish may also be transported in baskets, whose wicker-work is sufficiently wide to let the air through, and which are placed on mules, donkeys, or horses. In such baskets the carp are generally placed on the stomach. For this purpose baskets with compartments will be the most suitable, in which the fish can be transported safely, as each compartment receives only one layer of fish. If the fish are to be sent to any considerable distance in these baskets, they should be packed in the same manner as described above."

Tscheiner thinks that this is the safest method of transporting carp. If carp are to be sent a distance of only 14 to 22 kilometers, they may simply be placed in a cart well padded with straw, and a thick layer of straw, well fastened with strings, be put on the top of them. Upon arrival at their destination, the carp must not be immediately placed in deep water, but they should be placed in water where they can be watched until they have sufficient strength to swim about in the pond.

The above are the methods of transporting a large number of fish. Singly carp are transported in the following manner: The fish are laid on the back upon a thick layer of clean and fresh moss, which is moistened from time to time. A small piece of apple or moistened bread is occasionally put in the gills of the carp. The fish must lie immovable, and have its mouth free. Packed in this manner the fish is put in a

hand-basket. After eight or ten hours it is taken out, the piece of apple is taken from the gills, and fresh air is blown into them. After this has been done, the fish is put in its natural position into water, which is 10 to 20 centimeters deep, if possible, where the water is running, holding it with the hand all the time. If the fish does not move, air must be blown into its gills once more. This process is repeated every day until the destination is reached. All other kinds of fish, with the exception of eels and tench are transported without any water. According to Von Ehrenkreuz,* carp can be transported alive any day in the year, if a small piece of bread moistened with vinegar or brandy is put in its mouth and renewed from time to time. The fish are enveloped in straw and sewed up in a piece of linen. In winter the fish are packed loosely in snow, when they get into a sort of torpor, from which they revive as soon as they are carefully put in water. During the transportation they should not be left in a warm place for a single moment. Pike may also be transported in this manner.

X.—The Keeping of Fish.

In tanks or small ponds.—If at the autumn fisheries all the fish are not immediately sold at the dike they should be placed in small ponds to be kept till they can be sold with profit. Here they are kept both winter and summer, to be taken out as demand arises. There should be a greater or less number of these ponds according to the extent of the pond farm, the number of fish, and the number of different kinds. These ponds should be located as near the center of the pond farm as possible, so as to make the transportation from the large ponds less expensive and difficult. Where large quantities of fish have to be kept, the ponds, or tanks, as they are sometimes called, should be 10 meters long, 10 broad, and 3 deep. The depth of water, however, should be only 2 meters. It is advisable to line the sides with brick-work and cover it with a coating of cement. This becomes absolutely necessary if the soil is loose. If this is not done, the sides should be made as smooth and firm as possible, so that the fish cannot hurt themselves by pushing against any projecting points, such as stones, roots, &c. The bottom of carp tanks should be covered with clay or loam, which must be renewed every year; while the bottom of tanks intended for pike, perch, and trout should be covered with gravel, and that of perch-pike tanks with sand. The sides of the tank should slope gently, so that during winter there is no danger that the ice may injure the fish. The bottom of the tank must slope a little towards the outflow pipes so that the mud may be carried that way; and the pipe must be lower than the bottom, so that the tank can be thoroughly cleaned of mud and laid dry. The pipes should have grates on the inside of the tank, double grates placed at an angle being the most suitable. In tanks where fish of prey are kept, these grates

* Von Ehrenkreuz, *Angelfischerei*, 1873, p. 137.

should be very narrow, so that the small fish which serve as their food cannot escape. A few steps should lead from the edge down to the water. Tanks having the dimensions given above can hold 20,000 to 25,000 pounds of carp during winter, if there is a strong current of water; while in summer, if the current is weak, they will only hold half that quantity. As every kind of fish should have a separate tank, a number of these will be needed; they should all be in a row separated by wagon-roads about 3 meters broad. On very large pond farms it may be necessary to have several rows of tanks. The water for these tanks had best be supplied from ponds on higher ground. Such water is in all cases preferable to river or brook water, because it has a more even temperature, and during the thaws of spring does not carry any snow water into the tanks. Spring water is still better than pond water. A separate ditch should, if possible, lead from the main ditch to every tank. To keep the water at an even height, the influx and outflow should be steady. For this purpose it will be advantageous to have on one side of the tanks an influx and outflow ditch side by side, so that each tank may be supplied with fresh water and drained whenever necessary.

The more tender kinds of fish should be in the tanks which the water enters first; the order in which the fish occupy the tanks should, therefore, be as follows: Perch-pike first, followed by pike, perch, carp, and tench. Pike must be separated according to their size, so that the larger ones do not devour the smaller ones. When fish of prey are placed in tanks the inferior fish which serve as their food should be put in at the same time. Eels are kept in special boxes placed in one of the larger ponds. These boxes should be well secured, so the eels cannot escape. Horak recommends putting all the carp from one and the same pond in special tanks, because fish from different ponds, from some unexplained cause, will not be able to stand the winter weather equally well. Thus carp from one pond can easily be kept till after Easter, while those from another pond must be sold at Christmas. If fish from different ponds are mixed in one and the same tank, they must be constantly sorted, which is difficult, expensive, dangerous, and absolutely impossible if the pond is covered with ice.* As the contents of these tanks are exceedingly valuable they should be inclosed by walls or fences, and a watchman should dwell close by, aided by a good watch-dog. On a large pond farm, *i. e.*, where there are a great many tanks in which fish are kept for different fish-dealers, it is absolutely necessary that a special superintendent should be appointed who supervises the placing of the fish in the tanks, and from these, when needed, into the kegs, and keeps an accurate account. Where the quantity of fish which are to be kept is not very large it is best to have more small than large tanks. The carp can then be placed in one or several large tanks, while pike, perch-

* Horak, *Teichwirthschaft*, 1869.

pike, trout, and all those fish of which only a small number is kept are put in small tanks.

If during severe winter weather the ice in the tanks gets very thick, it must be removed so that the fish cannot hurt themselves by knocking against it. On small pond farms which have only a few small tanks, it will be well to prevent entirely the formation of ice by covering them in very severe cold weather with poles, over which is spread a thick layer of straw; on days when there is no frost this covering is taken off and again put on in the evening. If snow falls, it must be removed every day, so that the air has free access to the tank at all times. In very cold weather water should be poured into the tanks from time to time, especially when the influx and outflow are not regular.

In fish-houses.—Von Reider* gives the following directions for erecting fish-houses over brooks and ponds, which in medium-sized and small pond farms may prove useful: "Fish-houses are the most suitable receptacles for fish. They consist of large and small buildings according to the extent of the fisheries which they are to serve. They are placed over brooks or ponds which have a strong steady current. All kinds of receptacles for fish are benefited by being placed in swift-flowing water, or in ponds where many springs keep the water always at an even depth. Fish-houses may be of different size and shape, but they should never have more than one story. Their size will depend principally on the internal arrangements. The walls may be entirely of stone, or better still of framework filled in with clay. The walls of many fish-houses are composed of simple boards. Stone walls, of course, afford greater security; but boards keep the house warmer. The low roof is covered with reeds or straw, but in such a manner as to admit the air, which is very beneficial for the fish during their long imprisonment. According to the size of the house and the quantity of water, it contains either one or several fish-tanks. The houses should, if possible, rest on pillars or posts in the water, so that air and water may enter the different tanks simultaneously, at least on three sides. The separations of the different tanks or compartments, which have to be in the water, are made either of laths or boards, through which holes have been bored at certain intervals. Laths are preferable for this purpose, and may be intertwined with willow branches. Nets may also be employed for this purpose (I, for my part, would not recommend these, as they soon rot when left in the water for any length of time). At the bottom these tanks must be fastened to the depth of about 60 centimeters, between two beams. To secure them still more they are inclosed by strong poles placed at intervals of 60 centimeters, which rise 60 to 90 centimeters above the surface of the water, so that ice and drift-wood may not do damage to the inclosure of laths. It is very advantageous if the water can fall into the tanks from some height. The water in the different compartments should always be deep enough to prevent its freezing in winter.

* Von Reider, *Das Ganze der Fischerei*, 1825.

The size of the compartments depends entirely on the purpose which they are to serve. It may, under certain circumstances, be advisable to make the separations movable. It is absolutely necessary that light and air should have free access to all the compartments from above. In constructing these compartments care should be taken to have them arranged in such a manner as to give to each kind of fish the water and soil which their nature requires. Thus, in the first compartment, where the water enters, are placed trout, barbel, and *Thymallus;* in the second, pike and perch; and in the others, carp, whitefish, tench, &c. The size of the compartments should be regulated by the quantity of the different kinds of fish. Pike, barbel, or trout, *e. g.*, will never be kept in as great quantities as carp. Stone should be put in those compartments where trout or barbel are kept, as these fish, like the crawfish, love to hide under stones. The soil is left as nature has provided it. It is better to have several small compartments than a few large ones. It is immaterial what kind of wood is used for these compartments as long as it is thoroughly dry; generally, however, pine wood is used. Fish should not be put in the compartments until the water has been allowed to flow through them for two to four weeks, so as to take away the odor of the fresh wood.

"No general rules can be laid down as to the number of fish to be put in one compartment, and but too frequently it will be necessary to crowd some of the compartments. In winter, or whenever the weather is cool, and in deep and constantly fresh water, no evil results will follow, provided this crowding does not extend over too great a period of time. The compartments should be inspected every day, and dead fish, which will float on the water, should be removed as soon as possible. The most important point is cleanliness. If the water falls into the compartments from above, and a lively current goes through all of them, no further cleaning need be done; but if this is not the case fresh water should be allowed to flow into the compartments from time to time. In constructing a fish-house care should be taken that the water is clean, and that it does not come from places where there are breweries, tanpits, rettings, &c. If the fish or pond master lives in the fish-house, his dwelling should be below the outflow. The different fish in the various compartments should have separate tanks; eels, for instance are kept most safely in strong wooden boxes, because otherwise they are apt to burrow in the bottom, and in this way make their escape from the fish-house. In fish-houses fish must be fed, and a sufficient supply of food suitable for each kind should be kept on hand."

From the above it will be easy for a pond cultivator to select the method of keeping fish best adapted to his circumstances. Brief mention should be made of the superintendent's dwelling in the fish-house, which should have a roomy shed and an airy garret for keeping the fishing apparatus and for drying the nets.

The work at the tanks consists in placing the fish in them, in super-

intending them, and in taking fish out of them. The superintendent should be a particularly faithful and reliable man, who should, at least for the work of stocking the tanks and taking out of the fish, have some assistants. The fish ought not to be thrown from the keg directly into the water, but should be allowed to slide slowly into a van held close to the opening of the keg. From this van the fish are carefully put into the water one by one and counted, the person who attends to this work standing on the steps leading down to the water. On large pond farms, like that of Wittingau, the fish are first put in tubs, and from these they slide down into the tank on a trough, which is well lined with straw. If any of the fish are injured or languid they must be placed in separate tanks, where they are carefully watched, and should be sold as soon as possible. As soon as a wagon-load of fish has been put in the tanks, the superintendent gives the driver a receipt and gets one from him. Orders for taking fish from the tanks are given the superintendent a day beforehand by the manager of the farm, who receives the orders from the fish-dealers.

When fish are to be taken from the tanks the water is let off, as much as is necessary to take the desired number of fish with a purse-net. In spring, summer, and autumn, this work is not very difficult; but in winter, when the tanks are frozen, it is much harder. Before the water is let off, the ice over the deepest place, where the fish generally congregate, should be broken, or, better still, sawed and removed. The fish are then taken out and put in a tub which holds about 200 pounds of carp. From this tub they are counted into large pieces of cloth (as described in a previous chapter) and put in the kegs. The superintendent meanwhile puts down the name of the driver and the number of fish; and after these have been delivered to the fish-dealer, he receives from the driver a receipt signed by the dealer. At the tanks a portable scale should be kept, which is specially needed if the fish have not already been sold at the autumn fisheries and are kept in the tanks at the risk of the buyers, but are sold in the course of the year, whenever it can be done with some profit.

In small fish-tanks.—In order not to disturb large tanks on account of a few fish which the pond owner may want for his table, every pond farm should have a number of small fish-tanks for keeping a limited number of fish for the purpose indicated above. Such tanks are generally constructed in brooks and rivers which never freeze entirely, or in ponds. They may be like the tanks in the fish-houses, only on a smaller scale; frequently, however, a perforated box will answer the purpose. This box, which should be kept locked, is attached to two posts by ropes or chains, so that it can be let down to the bottom and drawn up again. Wherever the opportunity offers, such small fish-tanks should be constructed in springs. I had a small tank in a spring in which the fish were kept all the year round. It was constructed close by the outflow of a strong spring, and consisted of three pits let into

the ground to the depth of 1 meter, lined with bricks and cement, and measuring 1 meter in length and breadth. The water was never deeper than 60 centimeters. It entered the tanks at a distance of about 60 centimeters from the spring, and flowed through openings measuring 2 centimeters in breadth, and made at the height of 60 centimeters, from one tank into the other. The whole was covered with a little shed, about 60 centimeters high. At the front there were three doors, which could be locked. In this tank I could easily keep (in one compartment) 60 carp, weighing 2 to 3 pounds apiece. Pike I never kept in it for any length of time, because it was difficult to supply them with the necessary food. Similar tanks may also be constructed near wells with running water.

Jokisch gives the following directions for keeping fish alive for several days: "If there is no running water near at hand, and if it is desirable to keep fish for several days, as may be the case in cities or in small households, art must supply what nature has not furnished. Three vessels, all of different size, are needed. The largest is put underneath and serves to receive the water. Two sticks of wood are laid across it, and on these is placed the vessel containing the fish. On the top is placed the third vessel filled with water. A hole is bored in the upper and middle vessel and a quill is inserted, through which the water runs and is constantly kept in motion. This apparatus, of course, needs watching. Fish may in this way be kept for from eight to fourteen days. If the vessels are large, fresh water need not be added till after 6 or 8 hours."*

B. von Ehrenkreuz says:† "To keep fish when out of the water alive for several days, all that is necessary is to intoxicate them. In winter it is sufficient to put in their mouth a piece of bread soaked in brandy and cover them with snow, or if that cannot be obtained, with straw. In summer beer or wine may be substituted for the brandy—the beer should not be sour—and the fish should be wrapped in fresh grass or moss which should from time to time be moistened with the same liquor as the piece of bread. In this manner carp, tench, pike, and other large fish can be kept alive from twelve to eighteen days. When taken from their wrapping of moss or straw, the fish appear to be in a torpor, but they are soon revived by taking the piece of bread out of their mouth and wrapping them in a piece of linen which is gradually moistened with water. They are finally put in a vessel filled with fresh water, where they soon swim about in a lively style. Eels need be covered only with moist earth or grass. With some care and by keeping up a moderate degree of moisture they can be kept for a month.

* Jokisch, *Handbuch der Fischerei*, 1804.

† B. von Ehrenkreuz, *Angelfischerei*, p. 209.

XI.—Other Objects of Pond culture.

Other objects of pond culture are (1) willows, (2) grass, (3) reeds, (4) mud, (5) different kinds of grain or plants.

(1) *Willows.*—To plant the dikes with willows is the best way for rendering them safe for a long time. Willows, moreover, yield a considerable income from the sale of branches for making baskets. No pond cultivator, therefore, should neglect to plant willows on his dikes. The planting by means of wicker-work is preferable to that by shoots stuck in the ground, as the former affords protection against breaks in the dike even before it has fully taken root, while the shoots will be able to resist the water only after three or four years, when the dike is permeated in all directions by the roots. The planting of willows has already been spoken of in the chapter on the construction of the dike. We shall, therefore, confine ourselves to giving a few hints on the subject, following in this a treatise by Mr. Ernst Heger,* who has given much attention to the matter. Willows can be planted in autumn, during winter, or early in spring. The willow plantation must be kept clean of weeds, especially of *Conalvus sepium*, which may prove very injurious. The *Untica dioica*, the different varieties of *Spiræa*, and the *Rubus cæsius* must be carefully weeded out at the time of blooming. After the willows have been cut in autumn the weeds and grass can be hoed, turned, and left for manure. The weeds and grass should be cut once or twice with a sickle during summer. It should be left to the discretion of the pond cultivator whether he wants to harvest the hay or whether in some places he will let it decay and serve as a fertilizer. The willow plantation may also be injured by fungi and by various insects, especially *Cossus ligniperda*, *Fidonia progemmaria*, and *Liparis salicis*, which should be removed as soon as they show themselves.

Willows which have not been disturbed or injured in their growth can be cut in the first year. The shoots are cut at half their height. From the second and third year a willow plantation will, under favorable conditions, yield a rich harvest, which reaches its normal height in the fourth year. It remains the same till the eighth or ninth year, when it begins to decline. To prevent this the trees are cut off close to the ground every seven or eight years, and in this manner a plantation may be made to yield steady harvests for about thirty-five years. Trees which have died must immediately be replaced by others. The simplest way is to bend over a branch from the nearest tree and stick it in the ground, severing it from its parent stem when it has thoroughly taken root. For cutting the branches a sickle-shaped knife with a hand-strap is used. In doing this a man stands close to the tree, takes all the branches springing from one head under his left arm, and severs them from the tree by one rapid cut made in an upward direction. Among the serviceable branches, every willow tree has some sickly or crippled

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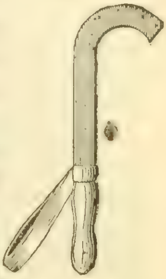
* *Wiener Landwirthschaftliche Zeitung*, 1876, No. 10.

ones. The laborers frequently overlook these in cutting. This should not be allowed, however, for these crippled branches will be the first to grow in the following year, and will hinder the growth of the healthy branches. The entire work connected with the willow harvest had best be done by contract. The amount paid for cutting, binding, taking to the wagons, and loading of 100 bundles of willow branches—the bundle measuring about 1 meter in circumference at the lower (thicker) end—is generally 8 to 9 marks [$2 to $2.25]. One laborer can cut thirty to sixty bundles per day. The wages are still better if three men work together, and let a woman do the binding, for which they pay her 2 pfennige (one-half cent) per bundle. The cutting of the willows can only be done, without injuring the stems, in the period between the fall of the leaves and their sprouting in spring. If basket-makers have rented a willow plantation, they like to do the cutting at the time when the sap rises in the trees, so that the branches can be peeled immediately. If cutting, however, is repeatedly done at that period, the plantation will soon be ruined. After the branches have been cut they are either sold immediately, with the bark on, or peeled later and sold as white willow branches."

Fig. 44.



One hectare of willows yields per year about 800 bundles of willow branches (with the bark on), viz.:

Number bundles.	Quality.	Per 100.	Value. Marks.	Value. Dollars.
		Marks.		
500	First	50	250	62 50
200	Second	30	60	15 00
100	Third	15	15	3 75
Total			325	81 25
Deduct expense of harvesting 800 bundles, at 8 marks per 100			64	16 00
Net profit			261	65 25

If the willow branches are sold peeled, the 800 bundles can be sold for 596 marks [$149]. Besides the expenses for harvesting, the following will be the running expenses of a willow plantation per year and per hectare: 500 shoots at 2 marks per 100 = 10 marks [$2.50]; cut down 300 old trees at 3.32 marks per 100 = 10 marks [$2.50]; weeding, &c., 5 marks ($1.25]; total, 25 marks [$6.25]; leaving a net profit of 236 marks [$59] per hectare.

The capital invested in starting a willow plantation need not be taken into account by the pond cultivator, as, strictly speaking, the willows are not planted for the direct purpose of yielding income, but for strengthening the dike, for which they are absolutely needed. The capital invested should, therefore, be accounted for under the head of

dike expenses. The entire expense of starting a willow plantation, however, will be 1,340 marks per hectare [$335], the interest on which sum at 5 per cent would be 67 marks [$16.75]. To this should be added about 10 marks [$2.50] per hectare for taxes and various incidental expenses; so that a total of 77 marks [$19.25] would have to be subtracted from the net profit given above if the willow plantation was to be considered independent of the dikes. It is difficult to say to which variety of willows the preference should be given, as this will mostly depend on local circumstances, the nature of the soil, &c. Basket-makers want willow branches which are as long and thin as possible, exceedingly pliable, and which, when peeled, have white wood with a natural gloss. Most of these qualifications are found combined in the *Salix vitellina*. Next to it comes the *Salix aurata*, which has comparatively short branches, which, however, are exceedingly fine and suitable for fancy baskets, and finally the *Salix purpurea* and a variety resembling the *Salix viminalis*. The branches of the *Salix purpurea* and its varieties are particularly distinguished by their slender growth. *Salix pentandra* and *Salix viminalis* have also long branches, but these are also very thick and are not suitable for peeling. They are all the better for coarse wicker-work in which the bark is left on the branches. The pond cultivator has it in his power by suitable treatment to cause the branches to grow longer at the expense of the thickness. If planted very close together even the otherwise useless *Salix fragilis* does not have any side branches, but produces long and slender branches like the *Salix viminalis* and the *Salix pentandra*, while these latter, if planted close, will furnish also some material which can be used for fine work. Recently the *Salix caspica* has been favorably mentioned. It has a bark of a dark violet color and a very white wood, and it is said that in one year it grows very high and slender, and in the third year has many branches measuring 2 to 2½ meters in length, and a very large number measuring 1 to 2 meters. It requires a sandy loam soil which all summer through contains some moisture.

The cuttings, measuring about 30 centimeters in length, are planted in autumn, or early in spring, by sticking them into the ground in an oblique direction, so that about two-thirds of their entire length is under the ground and one-third above. They are planted at intervals of one-half or 1 meter, according as one desires thick or thin branches. At the latest, every spring all the branches which have grown during the year must be cut 3 to 5 centimeters from the stem. The thin branches may in part be peeled, and in part be used with the bark for fine wicker-work, while the thick ones, with the bark on, can be used for coarse baskets, &c. We would advise every pond cultivator to sell only his willow branches with the bark on, as he will be busily engaged with his ponds at the very time when the branches should be peeled. We shall, therefore, not give any details as to the methods of peeling. Any one interested in the subject will do well to peruse a pamphlet by

Mr. Krahe, in Prummern, near Aix-la-Chapelle, Prussia. This little work gives Mr. Krahe's experiences with a willow plantation of an area of 375 hectares in the valley of the river Roer-Wurm, gathered during a period of ten years. The plantations of the village of Wurm yielded a net profit, per one-quarter hectare, in 1870, of 79 marks [$19.75]; 1871, 82 marks [$20.50]; 1872, 100 marks [$25]; 1873, 123 marks [$30.75]; 1874, 152 marks [$38]; 1875, 227 marks [$56.75]; and 1876, 246 marks [$61.50].* The best way for the pond-cultivator will be to manage his willow plantation himself and not rent it out to any one, as it is not pleasant to have strange persons, *e. g.*, the laborers of the renter, about the pond at all times. Not only the dikes should be planted with willows, but also the banks and any waste places near the pond. The disadvantage of such plantations is, of course, that they become hiding-places for various animals which may injure the fish. Local circumstances will have to determine whether such plantations should be abandoned on that account.

(2) *Grass.*—The grass along the edges of the pond will in dry years, or when the pond is not filled with water to its utmost capacity, yield quite a little income to the pond cultivator. To cut the grass along the edges as long as these are covered with water is injurious to fish-culture, as the edges, when overgrown with grass, furnish the best pasture-grounds for the fish. After the fisheries are over the entire quantity of grass growing on the edges may be used for feeding cattle. It is very injurious to drain a pond on account of the hay harvest, which takes place at the very time when the edges yield the most food for the fish; and if it is desired to harvest the grass, it will be better not to have the pond very full of water and to make the number of fish proportionate to this quantity. Winter ponds which have lain dry during summer, or have been filled moderately with water for the purpose of being used as raising ponds, often yield a very considerable quantity of grass, which may be harvested without detriment to fish-culture. Any intelligent pond cultivator will find some way of harmonizing the interests of grass culture and fish-culture.

(3) *Reeds.*—Reeds may yield some profit, being sold for building material or for straw.

(4) *Mud.*—The mud of a pond forms a valuable fertilizer, which, if not used on the fields belonging to a pond farm, will always find a ready sale among the intelligent farmers of the neighborhood, who know its value, and who will at any rate remove it without charge. The best mud for fertilizing purposes is furnished by those ponds into which flows the rain-water from the surrounding fields, as it carries with it a great deal of animal and vegetable matter. The same may be said of ponds in which or along whose edges cattle are in the habit of grazing. The mud from ponds surrounded by forests or containing many reeds frequently contains too much acidity to use it as a fertilizer, and it should

* *Centralblatt für den deutschen Holzhandel,* 1877, No. 32.

simply be removed from the ponds from time to time. Before using the mud from ponds as a fertilizer the pond cultivator should have it carefully analyzed.

(5) *Different kinds of grain or plants.*—To sow the ponds at certain periods with different kinds of grain or other useful plants does not only add to the income of the pond cultivator, but it will also have a very beneficial effect on the growth of the fish, and can, therefore, not be recommended too strongly.

XII.—THE SUPERVISION OF THE PONDS.

A careful and constant supervision should be exercised over the ponds, as the results of pond culture will, to a great extent, depend thereon. The supervision of the ponds should be intrusted to a faithful, reliable, energetic, and thoroughly experienced man, who generally takes the title of "fish master" or "pond master." According to the extent of the pond farm he should have a number, more or less large, of assistants, called "superintendents of ponds," to each of whom a certain pond area is assigned, the pond master alone having the general supervision. Even if he does not take part in the manual labor connected with a pond farm, he should be everywhere and give his directions; nothing should escape his attention, and he should regulate and strictly supervise the work of the pond superintendents, who must make regular reports to him, and receive their orders from him. The pond master, as well as the pond superintendents, should frequently walk around the ponds; if their extent is not too great this should be done every day. In these daily rounds he must give his attention to everything which may be helpful or hurtful to pond culture, more especially to the height of the water, the condition of the dikes, the influx and outflow, and the grates; he should also ascertain whether traps have been set in places where this would be likely. Early in spring the dikes and other constructions should undergo a careful examination before the ponds are stocked with fish. If it is found that the dike leaks in any place, the necessary repairs must be made at once. The grates must also be examined, and, if necessary, repaired. They should at all times be kept free from grass, wood, and anything which may stop them up. When the thaws set in, in spring, even greater vigilance should be exercised so as to prevent any possible danger by inundations. For this purpose the ditches carrying off the superfluous water should always be kept open, and be cleaned at once if there is any indication of their becoming stopped up. Those ponds which during winter have been over-full of water should in spring be reduced to their normal depth; and the spawning ponds and raising ponds which have lain dry, after they have been examined carefully, and any pike which may have remained in them have been removed, should be filled with water. In those ponds which have been laid dry, and which are to be sowed, the ditches must be repaired and cleaned, and the small

ditches be put in order through which the water is to be let out from the reeds and deep places.

Ponds which have been constructed only the year before are likewise filled at this time (in spring), but should not be stocked immediately, but be watched for some time, to see whether they have been constructed in a thorough manner, so that any defects in the dikes, tap-houses, &c., may be remedied during the summer. In April the fisheries commence in the winter ponds and in those spawning ponds which have remained full of water during winter; the stocking of the spawning and raising ponds should also commence about this time. The pond master has to superintend the fisheries and the stocking of the ponds, to see to it that everything is done in order, and especially to watch the laborers that they treat the fish carefully and do not throw or press them too hard. He should appoint reliable persons to transport the fish to the spawning and raising ponds, and remind them not to throw the fish direct from the keg into the water, but to receive them into vans at the bung-hole and thence carefully remove them and put them in the water. He should also caution the men not to leave the ponds until they have convinced themselves that the fish have left the reeds and the edges and have gone into deep water. He should remind them to examine the kegs once more, before leaving the ponds, to see whether some of the fish have accidentally remained in them. The men ought also to examine the wagons to see whether the driver or some other person has secreted any of the fish. After every trip a report should be made to the pond master so he can see whether all his orders have been properly obeyed. If several wagons start on a trip together the person in charge should be on the last wagon, so that he may easily watch the rest. No larger number of wagons should be assigned to him than he can superintend conveniently. In transporting carp and placing them in the ponds double care and vigilance should be exercised, so that no fish are stolen. Eel ponds should be stocked with *montée* (young fry). If trout are to be cultivated the young fry should be taken from the spawning ditches to the raising ponds, unless, owing to late spawning, it is found advisable to leave them in the ditches till autumn.

After the ponds have been stocked they should be protected against thieves and animals which can injure or destroy the fish. The large spawning carp and pike in the stock ponds will be a special temptation to thieves. Both these kinds of fish go near the edges during the spawning season, and are at that time so little shy that frequently they can be caught with the hand. Special precautions should, therefore, be taken during this period. Relative to the protection of fish against thieves, Horak says:* "Among the dangers which threaten fish, thieving is the most serious. The art of catching fish varies greatly; and, if coupled with a mania for fishing or with a thievish propensity, it becomes

* Horak, *Teichwirthschaft*, 1869.

dangerous. To watch human beings who have lax ideas as to the right of property requires not only great vigilance and perseverance, but in this case also a thorough knowledge of the various methods by which fish can be caught. It is, therefore, necessary to appoint as watchman a person who is conversant with the methods of fish thieves. The principal apparatus employed by thieves are hooks and nets. To secure fish at night-time by means of spears will rarely be successful, as the light which is necessary will betray the thieves. Fishing with hooks and artificial bait will in most cases prove more successful. The various nets employed by thieves, in the hands of experienced persons, and especially if the ponds are not carefully watched, become exceedingly dangerous. The pond cultivator will probably know the localities where thieving is likely to occur, and should endeavor to make them as inaccessible as possible. In puddles below the grates, juniper and thorn brushwood should be laid and weighted with stones, so as to render a prolonged stay in them disagreeable and make it difficult to use the hook and line. If during high water the fish should nevertheless get into these puddles, thick pine branches should be thrown into them and be weighted with stones. Piles may also be driven into the ground so that the nets cannot touch the bottom.

As such depredations generally occur late at night, when the grass is wet from the dew, the tracks of the thief can easily be discovered in the morning. This makes it necessary to stop watering by night-time, and to do it not only by day, but also in places which are not too remote and lonely. Thieving becomes most dangerous prior to or during the fisheries, when the water is low and the fish congregate in a few places, and is then generally done by nets or with the hand. To prepare the ponds for the fisheries should invariably be done by persons specially selected for the purpose; and large or very remote ponds should be guarded by reliable men. To enable the watchmen to discover the track of a thief, the mud-covered bottom of the pond should not be trodden by any one, unless this is absolutely necessary. The supervision of large ponds with an extensive growth of reeds becomes exceedingly difficult. Experienced watchmen have many signs which betray the thief. Thus, wading in mud or water is heard at a considerable distance during the silence of the night. Aquatic birds, especially gulls, are watched to see whether they remain quiet in the middle of the pond. As soon as any one enters the ponds these birds rise with a great noise and thus betray the intruders. An experienced pond cultivator will at once perceive whether any thieving has been going on with hooks and lines, or nets; and, especially during high water, when the fish are frequently carried far away, he will take every precaution to prevent thieving, and if necessary call in the aid of the authorities. For injurious animals traps should be set. In small ponds wild ducks, gulls, &c., can be kept away by scarecrows, made as much as possible to resemble a human figure, whose location should be changed from time to time.

From the beginning of May the spawning of the carp should be watched, and all hurtful and disturbing influences be kept away as much as possible. During this period, and later, cattle should not be allowed to graze near the spawning ponds; tame ducks and geese should not be suffered on them, and nothing like washing should be done in them. The frogs should be caught as much as possible, as they devour not only the spawn, but also the young fry.

In July it can already be seen whether and how much fry there is in the ponds. If the young fry or all the fish belonging to a pond farm are to be fed artificially, the pond master should see to it that the fish are fed regularly. Care should be taken to keep an equal depth of water at all times. In his rounds the pond master should not neglect to examine the taps and stand-pipes, to see whether they have been opened, whether the water flows freely through the grates, or whether it is impeded by an accumulation of grass, mud, &c., which is frequently caused by mischievous persons. I have known a case where a miller who could no longer draw the tap, as had been his habit, because a long tap with a padlock had been substituted for the short one, threw a great quantity of earth and sod into the water near the outflow grate, so as to let the water flow into a pond near his mill, thus causing a continued unequal depth of water in the two ponds. The ditches through which water flows into the ponds should be kept clear all the year round, and this applies particularly to sky ponds. The influx of rain and snow water from neighboring fields and meadows should be favored in every possible way.

During the hottest months, June and July, the temperature of the water, especially in sky ponds, should be watched incessantly, so as to take proper measures in good time to prevent sickness and death among the fish. During these months, when the water is low, cattle should on no condition be allowed to come near to or enter the ponds, useful as their presence might otherwise be by the addition to fish-food which their excrements furnish. When the heat is very great, care should be taken to have all the ponds abundantly supplied with fresh water, unless this supply is regular and constant.

Inundations.—During rain-storms which may possibly be followed by inundations, the necessary precautions should be taken by letting as much as possible of the superfluous water flow off through the ditches intended for this purpose and by opening all the sluices a little. Even while the rain is falling the ditches should be cleared to prevent any accumulation of mud, &c., and the grates should be freed from plants, brushwood, &c., which may have drifted against them. If, in consequence of inundations, a break in the dike appears unavoidable in spite of all precautions, an opening should be made in some place where the damage will not be very great. A break in the dike near the outflow is especially to be avoided. After inundations steps should immediately be taken to gather the fish which have been scattered over the neigh-

boring meadows. If this cannot be done at once some trustworthy men should keep watch during the night to prevent thieving. An inundation will, of course, even under the most favorable circumstances, occasion some losses.

If a thunder-storm is approaching, all necessary precautions should be taken. The necessary boats, piles, poles, boards, ropes, sod, earth, clay, carts or wagons, carpenters' tools, shovels, pickaxes, rakes, &c., should be kept in readiness so as to be able immediately to erect protective works at threatened points of the dike and to remove grass, mud, &c., from the grates. If this becomes impossible, the grates must be removed altogether. If during a thunder-storm the lightning strikes a small pond, the water should be let off as soon as possible and be replaced by other water, as the sulphuric vapors with which the water has become saturated will generally kill the fish.

During July and August care should be taken to prevent the exceedingly injurious and even fatal retting of flax in the pond or its tributaries. Summer, particularly July, is the time when the growth of reeds is most luxuriant, and whenever they grow too rank they should be thinned out a little by cutting them below the surface of the water not far above the root. All the above-mentioned work is continued during August. In places where eagles pass on their way to the south, one should be on the lookout for them, and traps should be set in time. During this month (August) the preliminary work of the autumn fisheries commences. The fishing apparatus is overhauled and repaired; the fish-tanks are cleaned with a broom and washed. These labors are continued during September. During this month the winter ponds are filled. The fisheries commence in the spawning ponds which are not to remain filled during winter, and the young fry are put in the winter ponds. Those spawning ponds which are to remain filled during winter should be drained, as far as is necessary to ascertain the quantity and quality of the fry, and also to see whether any fish of prey have entered them, which should be removed at once. After this has been done, the ponds should be filled again immediately. The fisheries are continued in the raising and stock ponds, and the winter ponds should be stocked. Those fish which have reached a marketable weight are either sold at the dike or placed in tanks to be sold, whenever there is an opportunity. The stock ponds receive their quota of carp, young pike, perch-pike, or tench. The spawning carp are picked out and kept during winter in special tanks. Wherever trout culture is carried on, the time after the autumn fisheries is the proper season for stocking the spawning ponds, and making the spawning ditches accessible for the spawning trout. The fishing-apparatus is cleaned, the nets are dried and put in a safe place. During winter they should be repaired as much as possible.

The proper time has now also arrived to plant willows, which, if the weather is favorable, may be continued till spring. The branches of old willow plantations are cut and this is continued until the work is fin-

ished. The winter ponds—near which on large pond farms there lives a special superintendent—should be examined by the pond master every day, and, if necessary, several times a day. During the very first days after the fish have been placed in the winter ponds they should be carefully watched to see whether they become accustomed to their new place of sojourn, whether they have gone to their hiding-places and remain there quietly, or whether they frequently rise to the surface. If this is the case the cause should immediately be ascertained and remedied. If accidentally fish of prey have got into the ponds they should at once be removed. If the fish become languid, and keep near the surface, the water must be renewed; and if this has no effect the fish must be put in other winter ponds. If soon after the fish have been put in the winter ponds they seek their hiding-places, and stay there quietly, this is a sure sign that they have become accustomed to the pond and that the water suits them. Great care should be taken that the water flows in and out of the winter ponds freely and regularly, and as soon as ice forms near the outflow or influx it should be removed at once. The pond master should also give his constant attention to the tap-houses and grates and free them from ice, especially when thaw sets in, so that the ice cannot lift the tap and stand-pipe. If the pond master pays daily visits to the winter ponds, he will soon notice any indications of sickness among the fish and take timely measures to prevent its spreading. Wherever it is necessary, air-holes have to be sawed in the ice—not cut, because cutting will scare the fish from their resting-places and cause them to rise to the surface, when their fins will freeze to the ice. These air-holes should never be made over the lair of the fish, but at a considerable distance from it. The snow should always be cleaned off, especially near the air-holes. If thaw sets in, the water should be allowed to flow off the ice.

A lookout should be kept for otters, which like to visit the ponds during winter, and they should be caught or shot as soon as opportunity offers. Reeds protruding through the ice should be cut off. All that has been said regarding winter ponds also applies to fish-tanks.

If fisheries in open lakes or rivers are connected with the pond farm, the pond master should also give some of his attention thereto. In summer nets are used in the river and lake fisheries—the "wild fisheries," so-called—traps are set, and some fish are caught with hooks and lines. In July and August many bleak and other small fish are caught with hooks and lines. Eels are caught with the night-line. Crawfish are caught in the brooks, and net fisheries are carried on in the lakes and rivers. In autumn the line and net fisheries are continued. These few hints relative to the "wild fisheries" must suffice, as they do not properly come within the scope of this work.

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XXXIII.—SOME RESULTS OF CARP CULTURE IN THE UNITED STATES.

By Chas. W. Smiley.

A report of the distribution of carp, made by the United States Fish Commission, from the young reared in 1879 and 1880, has already been published in the report of 1882, page 943. In order to ascertain what success these persons had had, a circular was prepared and sent out in July, 1883, to over two thousand addresses named in that report. The circular was accompanied by a blank form containing 15 questions, as follows:

1. When did you first receive carp, and how many?
2. Have you received any since?
3. What have you kept them in? If a pond, state its size and depth, and the nature of its bottom.
4. How much water usually flows through it, and how cold is it?
5. What water-plants or grasses does it contain?
6. What other fish, frogs, turtles, &c., does it contain?
7. What food do you give the carp? How often?
8. How many carp have you of the original lot?
9. How many young have they produced?
10. What is the present size or weight of the old ones?
11. What is the size or weight of the young ones?
12. What disposition have you made of any of the young?
13. Have you eaten any carp? How were they cooked, and what was the opinion of their edible qualities?
14. Have the carp been troubled by any disease or fatality?
15. What has been your most serious difficulty in their care?

From the replies received to this circular and from the correspondence of the Commission the 1,036 statements which follow have been compiled. These are classified geographically as follows:

	Statements.
New England States	40
Middle States	176
Southeastern States	364
Southwestern States	249
Northwestern States	175
Pacific Slope and Great Plains	32
Total	1,036

The following exhibit shows the number from each State and Territory:

States and Territories.	Number.	States and Territories.	Number.
Alabama	21	Mississippi	43
Arizona	2	Missouri	26
Arkansas	1	Nebraska	3
California	8	New Hampshire	2
Colorado	12	New Jersey	29
Connecticut	21	New Mexico	2
Delaware	9	New York	65
District of Columbia	8	North Carolina	28
Florida	6	Ohio	69
Georgia	46	Oregon	2
Idaho	1	Pennsylvania	73
Illinois	26	Rhode Island	1
Indiana	17	South Carolina	36
Indian Territory	1	Tennessee	56
Iowa	7	Texas	67
Kansas	32	Utah	4
Kentucky	29	Vermont	2
Louisiana	6	Virginia	110
Maine	2	West Virginia	25
Maryland	105	Wisconsin	8
Massachusetts	12		
Michigan	8	Total	1,036
Minnesota	5		

The facts and opinions obtained concerning the edible qualities of carp have already been compiled and published in the Fish Commission Bulletin for 1883, page 305. An extra edition of this paper was published in pamphlet form and copies have been sent to persons making inquiries concerning the value of carp for food.

In the following statements the entire testimony is cited both for and against carp, in order that readers may be able to judge for themselves concerning its value and in regard to the standing of carp as an American food-fish.

It will easily be seen that the meagre results attained by some persons were due to a neglect of the following suggestions which the Commissioner has made to every applicant by printing them upon the blank form which each person desiring carp is required to fill out:

"It may be well to state that it is of no use to introduce carp in waters already occupied with such fish as bass, sunfish, perch, trout, or any other flesh-eating species whatever; even chubs and minnows are objectionable. Although the fish supplied might not be liable to injury, their eggs and young would certainly be devoured, and no result would come from the experiment. It is, therefore, recommended to persons interested in the subject who are not sure that their present ponds are free from fish, to begin by preparing a pond of say fifty feet square for the reception of the carp. After they have attained the age of from three to six months, they may be transferred to other suitable waters."

STATEMENT OF PERSONS ENGAGED IN CARP-CULTURE.

[Arranged alphabetically by States, counties, and post-offices.]

ALABAMA.

1. *Statement of H. M. Hunter, Eufaula, Barbour Co., Ala., April 7 and Sept.* 17, 1882.

DISPOSITION OF CARP RECEIVED.—I received 20 small carp, from 2 to 3 inches long, about December 20, 1881. My pond is from 8 to 40 inches deep, and is supplied with water from a number of fine, bold, clear and cold springs. It has a sandy bottom, and covers about one-half an acre, and is surrounded by ditches and an embankment of sand. The surplus water flows through a plank trough, which keeps the water of uniform temperature and depth.

PLANTS.—My pond is well-nigh filled with a long, tender, green and moss-like grass or growth, resembling purslain, though tender, and another kind, jointed, sending out roots at the joints, also delicate. These plants protect the fish from their bird enemies and make it more difficult for man to capture them, as the fish pass through these growths with ease and freedom. They protect the eggs, and also regulate the temperature of the water. Turtles may have an advantage in catching the fish in and about the bunches.

ENEMIES.—I know of a few snakes, one large and one small turtle, and 3 large bull-frogs in my pond. I have killed 8 fish-hawks and 4 white cranes. I examined the intestines of a small white crane that visited my pond, but I found nothing resembling, in the most remote degree, fish, tadpoles, or anything else save a quantity of fine black mud. I find my fish are much more shy than formerly.

FOOD.—I fed my fish regularly upon corn-bread twice a day until July last—six months after I received them. Since then I have fed them irregularly, and many days have given them no food at all. They seem careless in eating, and I never dreamed that fish could be made to grow as fast as my fish have. I am satisfied that they draw liberally from the natural products of the pond. The long, fine, tender fibers of moss also afford them some nutriment.

GROWTH.—April 7, 1882, I saw a dead carp in the edge of the water of my pond that was 9 inches from the tip of its tail to the end of its nose and was 2¾ inches at its greatest width. My son saw a carp which he says appeared to be fully as large as the dead one. The growth of the fish from 3 to 9 inches in length and 2¾ inches at its greatest breadth is truly remarkable, especially when we consider that the carp have been in the pond only about 4 months, and winter months at that, during which carp in the North are hibernating and not growing at all. Only 2 of the carp were 3 inches long when received; the other 18 did not average over 2½ inches. The fish that remain in the pond now (September 17, 1882,) average no less than 20 inches in length. I do not see more than 10 carp at any one time.

MISCELLANEOUS.—The dead carp had 4 wounds on its side and abdomen, having the appearance of being bitten by a small dog.

The grasses seem not to grow food for fish, but they seem to serve as a lodgment for certain food upon which the carp feed and do well. They can also hover under these grasses and partake of the food and protection unmolested.

2. *Statement of H. I. Irby, Eufaula, Barbour Co., Ala., Aug.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—I received 32 carp in December, 1880. The pond is one-fourth of an acre large and 7 feet deep, with a muddy bottom. It is furnished with water by springs which rise in and around it, and yield barely enough to supply the waste by evaporation.

PLANTS.—It contains the native bog-plants of the country.

ENEMIES.—There are bull-frogs and mud-turtles in it.

FOOD.—I feed them with bread and truck from the garden—not regularly; only enough to keep them gentle.

GROWTH.—I fried one of the old ones and one died; so I have 30 left. They are about 20 inches long; I do not know the weight. The young ones are about 15 inches long.

REPRODUCTION.—They have produced a great multitude of young; I have no means of knowing how many.

DISTRIBUTION OF YOUNG.—I sold some at from $5 to $10 per hundred, and have eaten some.

MISCELLANEOUS.—I did not know until the receipt of your circular that there were other varieties of carp. I should be pleased to get a few of each kind, as I am building other ponds and intend to make carp-culture a business.

3. *Statement of W. N. Reeves, Eufaula, Barbour Co., Ala., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—About three and a half years ago I received 20 carp and have received some since. I keep them in two ponds; one covering half an acre and the other 2½ acres. The bottom is muddy and the average depth is 5 feet. Water flows into the small pond from three springs—say 4 square inches; into the large one through a flume of about 10 square inches. My plantations are under the care of my agents, who have not time to give enough attention to the carp.

PLANTS.—The ponds contain wild grass and some water-lilies.

ENEMIES.—The large one has in it catfish, bull-frogs, and other animals; also small turtles. There are none but carp in the small pond.

FOOD.—The fish are seldom fed at all. They are occasionally given fresh meat; sometimes baked dough.

GROWTH.—Mine at the end of 6 months had grown from the size sent me to 8 and 12 inches long. At that time my dam broke. I saw and measured but did not lose them. They were all in the pond; none had died or been lost. Some seem to be 18 inches long now. I can't catch them. I tried with hook and line and can't get them. Only caught two—12 and 18 inches long.

MISCELLANEOUS.—So far as my information goes they will do finely here and be of great value to our people if properly taken care of. My purpose is to drain off my larger pond, free it of everything but carp, and give them a fair trial. I wish our people could be induced—those that live on their farms—to give them a fair trial. They will doubtless thrive and do admirably in this section.

4. *Statement of P. H. Coleman, Union Springs, Bullock Co., Ala., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp three years ago, all of which got away. In December, 1881, I bought 25 scale carp of Mr. Wright, of Georgia. I placed them in a pond 75 by 100 feet, with a muddy bottom, which is fed by cool spring water at the rate of two gallons to the minute.

PLANTS AND ENEMIES.—It contains Bermuda grass and a few bull-frogs.

FOOD.—The fish are fed once every day with garden truck, table scrap, boiled corn and peas.

GROWTH.—The old ones nearly all survive, and weigh almost 2 pounds each. I am partial to the scale carp.

REPRODUCTION.—They had a few young ones last summer. This summer there are any quantity.

DIFFICULTIES.—I think the pond is too small and too deep.

MISCELLANEOUS.—I am surprised that every housekeeper does not raise carp. I am satisfied they will do well in almost any Southern waters. As to their being a game fish, there is nothing in our waters that equals them.

5. *Statement of Jas. H. Savage, Cross Plains, Calhoun Co., Ala., Dec.* 26, 1882.

GROWTH.—About February last I received 23 small carp, 7 of which were dead, having been in the hands of the express company four or five days. They all sickened and died except one as soon as we got them into fresh water. I kept that one in a 40 by 40 pool of fresh water, and it now weighs 1½ pounds.

6. *Statement of William I. Dunn, Sepulga, Conecuh Co., Ala., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in January, 1882. The pond in which I placed them is 20 feet square, has a very muddy bottom, and is furnished with tolerably cool spring water; the quantity is not large.

PLANTS.—It contains native grasses, but no water plants, and has grass and trees growing around it.

ENEMIES.—Small creek fish occur in the pond and some frogs and turtles.

FOOD.—I give them bread and scraps from the table once in three days.

GROWTH.—I do not know whether they have spawned or not. They were 8 inches in length eight months ago, since which time I have not seen them on account of the murkiness of the water.

7. *Statement of Mrs. L. K. K. Hogan, Selma, Dallas Co., Ala., Sept.* 15, 1883.

DISPOSITION OF CARP RECEIVED.—The carp I received last March are doing finely, though several of them died just after their arrival, probably due to being hurt on the way. My pool is fed by four springs and is beautifully situated.

FOOD.—I fed them every day with bread, biscuits, crackers, coarse hominy, and candle-flies (caught in soap-suds near the lamp every evening), and cut-worms from the garden. They seem to like candle-flies and cut-worms better than the other food. The large carp come to the surface to eat them.

GROWTH.—Those that survived the journey have grown immensely, and are more than a foot long.

REPRODUCTION.—The last week in June I found the pool full of young fish, exceedingly small; now they are about 2 inches long. There seem to be three sets of them. They are very gentle. I have never been able to find any eggs, but don't know how to look for them.

MISCELLANEOUS.—I have another pool 30 by 45 feet, containing trout. The water is very clear. I can see them at any time of the day. Some 500 or 600 of these trout were taken from a large pond and brought to my pool. I take great interest in fish-culture.

8. *Statement of R. B. Dunlap, Boligee, Greene Co., Ala., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received some carp about four years ago, and placed them in a pond covering one acre, which has a bottom half of black muck and half of gravel and sand. A three-fourths inch stream of water enters it from an artesian well; it becomes very warm in summer.

PLANTS.—There is a species of Bermuda grass in it, which grows very high.

ENEMIES.—It also contains perch, bull-frogs, and a few turtles and minnows.

GROWTH.—I do not feed them, and they have produced no young that I have seen. I am afraid that they are all of the same sex. I have 13 old ones, which all seem to thrive, and one of them, which I weighed last October a year ago, weighed 6 pounds.

9. *Statement of Greene B. Mobley, Eutaw, Greene Co., Ala., Sept.* 11, 1883.

DISPOSITION OF CARP RECEIVED.—November 11, 1879, I received 21 carp, 2 of which died. The remainder were put into a pond, with a muddy bottom, covering about one-third of an acre, and having a depth of from 4 inches to 6 feet. The pond is formed by a railroad embankment over a marsh, and cannot be drained. The marsh is caused by springs.

PLANTS.—The common swamp grasses grow around it.

ENEMIES.—I find in it some trout, an abundance of bream, and frogs and turtles.

FOOD.—I fed them often, for the first year, with corn-bread and crackers. Since then I have not fed them much.

GROWTH.—I have been unable to catch any of the large ones, but I can see them occasionally; they will weigh from 12 to 18 pounds. The young ones are of all sizes, from an inch long to from 6 to 8 pounds' weight.

REPRODUCTION.—I do not know how many young they have produced; but I have eaten several hundred, commencing in 1881.

STREAMS STOCKED.—I am satisfied that the creeks and branches are stocked below this pond. I recently saw a carp 12 inches long that was caught 2 miles below.

MISCELLANEOUS.—The lack of a good pond, capable of being drained, has been my most serious difficulty. I have now purchased an excellent pond 4½ miles from town, one-quarter of a mile long, 200 yards wide, and with a depth varying from 4 inches to thirty feet. I should like to get 20 of each variety of the carp to stock this pond.

The success of carp in this section is assured. In a few years the carp, in my opinion, will be the predominant fish here in all our ponds with muddy bottoms.

10. *Statement of James E. Webb, Greensborough, Hale Co., Ala., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 2 carp alive out of a lot of 25 or 30 sent by express in June, 1881; and 10 out of a second shipment in March, 1882. I got them for Mr. A. F. Flynn, who put them in a pond 60 feet square, with a depth ranging from 2½ to 5 feet. The bottom of the pond is muddy, and some boxes of gravel have been put on it. The supply of water comes from a spring, and is very cold; the inflowing stream is of the size of an inch.

PLANTS.—Water-cress and wild grass-head containing grass seed are found in the pond.

ENEMIES.—There are no other fish in it, and I have tried to keep it clear of frogs. I have had difficulty in protecting the carp from hawks.

FOOD.—They are given corn-bread, about half done, and worms once every day.

GROWTH.—The old ones are from 14 to 16 inches long and 4 inches thick, and will weigh 2 pounds. The young ones are from a pin's size to 2 inches long.

REPRODUCTION.—They have produced a great many young.

11. *Statement of M. Wilkins, Faunsdale, Marengo Co., Ala., July* 12, 1882.

GROWTH.—I received 20 carp, averaging about 4 inches in length, and put them in my pond on December 12, 1881. They have done splendidly, the remaining 9 being from 1½ to 2 feet long.

12. *Statement of M. S. Gilmer, Matthews, Montgomery Co., Ala., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp in 1881, 1882, and 1883. I placed them in a pond measuring 20 by 200 feet, with a muddy bottom, which overflows occasionally in winter. The water is warm from April to October. There are none of the 1881 lot left now, and but 6 of the 1882 lot. All of those of 1883 (60) are still left. I have now put all the carp in our creeks, and would like to get as many more this winter as possible.

PLANTS.—The pond contains Bermuda grass.

ENEMIES.—The crawfish in it were a great annoyance, but I have exterminated them.

GROWTH.—The carp are all of the same size; seem not to grow any the second year. They weigh about one pound each.

13. *Statement of H. M. Bush, Montgomery, Montgomery Co., Ala., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I have received 26 carp. The pond has a sandy bottom, is covered with sediment, and measures 80 feet up to 120 feet. There is water enough to fill a 6 inch pipe of continuous flow, and it averages 67°.

PLANTS.—Water grasses grow around the edge of the pond.

ENEMIES.—It contains bream, red-horse, perch, and some frogs and turtles.

FOOD.—We try to feed the carp daily with corn-bread, slightly baked, and slips of meat.

GROWTH.—I should judge there are 20 or more of the original lot that are still alive from the number we see when feeding them. They are from a foot to 16 inches in length.

DIFFICULTIES—We see no young fish which seem to be carp. There has been no difficulty with the carp except that we have not seen them increase as we expected. The fish seem to be livelier this year than heretofore. We have placed brush in the water for the spawn to attach to.

[Of course there are no young carp when he has so many bream, red-horse, perch, frogs, and turtles to eat all the eggs.—EDITOR.]

14.—*Statement of J. M. Falkner, Montgomery, Montgomery Co., Ala., Sept.* 19, 1883.

DISPOSITION OF CARP RECEIVED.—In the fall of 1880 I received 22 carp, and in the fall of 1881, 20 more. I kept the first lot in a small pool for about a year, and lost all but 6. The 6 remaining, together with a second lot, I put in a small pond formed by excavating the earth below a small spring and constructing a dam. It is about 60 feet wide, and the dam is 66 feet from the spring. The supply of water is about 3 gallons per minute The bottom is a mixture of sand and clay, and there is no vegetation in the pond. The pond has an average depth of 3 feet, and the carp keep it muddy all the time.

ENEMIES.—The few frogs which have appeared have been killed as soon as possible.

FOOD.—The fish have been fed daily with bread, cooked potatoes, cabbage, beans, lettuce, and occasionally with the refuse from dressing poultry.

GROWTH.—I think I lost but one of those placed in the pond. They will not, in my opinion, average over a pound and a half in weight.

REPRODUCTION.—There are no young ones in the pond, and I have not been able to discover any spawn, though I have placed brush there and everything I thought necessary. I attribute their failure to spawn to the smallness of the pond and to the lack of vegetation.

MISCELLANEOUS.—I have nearly completed a new ten-acre pond with an abundant supply of water, grass, &c. I shall also prepare several small breeding ponds, so as to hereafter watch their growth and movements more accurately.

15. *Statement of J. J. Sharer, Pine Level, Montgomery Co., Ala., Aug.* 31, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 in December, 1882. The pond in which I placed them covers an area of about three acres, and has a muddy bottom;

the surrounding soil is sandy. The pond has no inlet, being supported by springs in its bed. It is about 3 feet deep, on an average, and the water is not cold, but mild.

PLANTS.—It contains bushes. Their name is unknown to me.

ENEMIES.—There are in it pike, perch, catfish, trout, and roaches; also toads, bull-frogs, hard-shell turtle, and terrapin.

FOOD.—I give them bread about every two days.

GROWTH.—The old ones are about 8 inches long, and the young ones about 4 inches long.

REPRODUCTION.—Judging from their appearance in a drove I think there are about 100 young ones.

DIFFICULTIES.—I think they should have produced better, if no disease has been among them and they have not been eaten by other fish.

16. *Statement of A. G. Barnes, Gainesville, Sumter Co., Ala., Nov.* 7, 1881.

DISPOSITION OF CARP RECEIVED.—The carp received in January, 1881, I put in an artificial pond, 60 by 80 feet, having a depth of 4 feet in the center and 18 inches around the edges. It has a sandy bottom, covered with 2½ inches of sediment, and leaves that fall from the trees which shade the pond. The spring that rises in the bottom of the pond supplies it with water, the surplus water running out at one side.

ENEMIES.—On May 12, 1881, I found that the perch which inhabited my pond had destroyed all of my carp but 7.

GROWTH.—When I examined my pond on May 12, 1881, I found that the 7 carp had made a wonderful growth, the largest being 10½ and the smallest 8½ inches in length. On July 20, 1881, the largest had attained a length of 15 inches, and the smallest 12¼ inches. October 20, 1881, the largest were 16½ and the smallest 15 inches long. From the rapid growth my carp have made, I am inclined to believe that all the conditions necessary to their successful culture exist in my pond.

17. *Statement of A. G. Barnes, Gainesville, Sumter Co., Ala., April* 21, 1882.

GROWTH AND REPRODUCTION.—Those received January 12, 1881, are now 20 inches in length. The first indications noticed of their breeding occurred March 19, 1882. Eggs found attached to the grass were taken and placed in a tub. The young were seen on the seventh day afterwards; the weather cool and wet. Again, on the 3d instant, I saw them deposit their eggs. A lot of these eggs placed in a tub hatched out on the fourth day; the weather warm and pleasant; the water during the day indicating about 70°. Those hatched on the 26th of March are now 1¼ inches in length. The prediction that they would spawn in the South in their second year has proved true. My carp have made more rapid growth and have propagated a year sooner than in their native waters.

MISCELLANEOUS.—I have not tested their eating qualities, but as my pond is now well stocked, I propose to try one or two of my breeders as soon as they recuperate from the exhaustion necessary to spawning. My success so far has been eminently satisfactory, and now, when I find by test that I have, in addition to his other good qualities, a good food-fish, I shall be more than compensated for my trouble, expense, and waiting. With my experience I do not hesitate to say the Southern waters are peculiarly well adapted to the propagation and rearing of carp.

18. *Statement of Marcus Parker, York Station, Sumter Co., Ala., Aug.* 7, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp November 26, 1879. The dam to my pond broke soon after I received them, and I lost every one.

19. *Statement of Dabney Palmer, Snow Hill, Wilcox Co., Ala., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in January, 1881, but they were frozen, and I think they died. My pond is 70 yards square and 5 feet deep, with a muddy bottom. About 100 gallons of water enter it per hour. I don't know the temperature, but it is about the same as that of our Southern creeks. Please send another lot of carp.

PLANTS.—There is a water-grass growing around the edges, of which I don't know the name.

ENEMIES.—There are bull-frogs and toads in it in the spring.

ARIZONA.

20. *Statement of Thomas G. Greenhaw, Phœnix, Maricopa Co., Ariz., July* 14, 1884.

GROWTH.—The first carp sent me have done very well, some having attained a weight of from 3 to 4 pounds. One lot of the carp spawned the last of June.

21. *Statement of C. L. Whitney, Pinal, Pinal Co., Ariz., Aug.* 18, 1884.

GROWTH.—The carp received last winter have done finely. I have one dozen which are each a foot or more long, and will average 1¼ pounds. An artesian well supplies my pond with water, which is always of a given temperature. The water runs through the pond continually.

ARKANSAS.

22. *Statement of Enos W. Smith, Arkadelphia, Clark Co., Ark., March* 17, 1884.

DISPOSITION OF CARP RECEIVED.—The 20 carp received January 6, 1882, I put in a pond 45 by 90 feet.

ENEMIES.—The carp are only troubled by crawfish, which, at this season of the year, disturb the banks of the pond.

GROWTH.—Last October I caught a carp that weighed over 5 pounds.

REPRODUCTION.—The pond is full of young of all sizes.

MISCELLANEOUS.—Below the pond in which the carp are kept I am constructing another, which will cover more than 1½ acres. Water will be let in next week.

CALIFORNIA.

23. *Statement of Richard Threlfall, Washington Corners, Alameda Co., Cal., Feb.* 6, 1883.

REPRODUCTION.—I placed 50 carp in a one-acre pond in April, 1881. On drawing the pond in January, 1882, I found 1,480 carp. I enlarged the pond to 2 acres, and drew it in January, 1883, and found 5,000 carp, the largest weighing 4 pounds.

24. *Statement of Wendall Dages, Big Trees, Calaveras Co., Cal., Jan.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—I have a pond of about half an acre, and about 20 inches of water running into it. The water is rather cold, as it comes through a cañon running nearly east and west and densely timbered. It is fed by springs, and has an altitude of 4,500 feet above the sea. I put evergreen boughs of the yew tree into the pond. Last spring the fish seemingly were spawning among the boughs, but they afterwards went into deep water and did not come out for nearly two weeks.

FOOD.—They did not eat anything during that time that I could notice. They were always together, and nearly always in the same place.

MISCELLANEOUS.—I have been cultivating carp two seasons, but they have not increased yet. There are a great many engaged in carp-culture in California, where, in the valley, they pump water with wind-mills to supply their ponds. In the mountains some have extraordinary success and others about the same as mine.

25. *Statement of Julius Weyand, Little Stony, Colusa Co., Cal., March* 29, 1883.

GROWTH AND REPRODUCTION.—My last year's product of scale carp was as follows: from 7 pair I have 341 carp from 3½ to 4½ inches long.

DISPOSITION OF YOUNG.—I drained the first pond on the 10th, and put the minnows into a new pond. I have not lost a fish since I have had the carp.

26. *Statement of J. H. Pettit, San Bernardino, San Bernardino Co., Cal., Feb.* 21, 1881.

DISPOSITION OF CARP RECEIVED.—On April 16, 1879, I put 89 scale carp, measuring from 2½ to 4 inches, and 5 carp, measuring from 6 to 7½ inches in length, in a little pond, which I subsequently enlarged to 1 acre and 3 rods. Mine is a sulphur pond, newly excavated; was strong with iron, and the ground was black with alkali. The fish, winds, and caving of the banks keep the water very muddy. My 94 scale carp cost me $100.

GROWTH.—In February, 1880, one of my old carp measured 24½ inches in length, and the ones I sold in November weighed from 6 to 7 pounds. A friend at Compton, Los Angeles Co., writes: "I placed in my pond on February 20, 1880, 10 of the carp I obtained from you. On December 5 I drew off my pond and caught and carefully weighed my carp. They measured from 18½ to 23 inches in length, and weighed from 4 to 7 pounds, the largest measuring 15 inches in circumference, and the aggregate weight of the 10 being 51 pounds."

REPRODUCTION.—To my great surprise, I had 4,500 carp in my pond in the fall of 1879, and in the following February they were from 2½ to 15 inches long.

AN EXPERIMENT IN MINERAL WATER.—Dr. Smith put 4 small carp in a pond of mineral water in which other fish died immediately, and in the following November, in the presence of his wife and friends, caught one which weighed 6¼ pounds, and measured 23 inches in length and 14 inches in circumference.

27. *Statement of the California Fish Commissioners, San Francisco, Cal.*, 1880.*

DISTRIBUTION OF CARP RECEIVED.—Of the 300 carp brought to California December 29, 1879, but 2 perished. Sixty were placed in a public lake near Sacramento; the remainder were placed in a private pond of R. R. Thompson, in Alameda, who promised to protect them and allow the State to remove them and the increase whenever desired. We have no report of those placed in Sutterville Lake; probably none of them have been caught. Those placed in the private pond at Alameda are doing well. These fish were hatched from the egg in June, 1879, and when received averaged about two inches in length. During the month of June, 1880, 12 were forwarded to Mare Island.

GROWTH.—In June, 1880, one year from the time they had left the egg, they had grown to a length of more than 8 inches. The increase in the size of the fish and their fine appearance make it certain they have found congenial homes. They were probably too young to have spawned last year. The 8 carp of another variety brought to this State in 1872, from Hamburg, by Mr. J. A. Poppe, have increased largely and have been widely distributed. Whenever planted in our water they have grown rapidly and multiplied in numbers. No other variety of fish has been so long under the care and protection of man, and no other seems so capable of domestication.

HABITS.—At the beginning of the cold season carp seek deeper water, making holes in the mud, where they pass the winter in a kind of sleep. They make a cavity in the muddy ground called a "kettle." In this they pass the time until spring, huddled together in concentric circles, with their heads together, the posterior part of the body raised and held immovable, scarcely lifting the gills for the process of breathing, and without taking a particle of food. It is a most striking fact that the carp, though it does not take any food during this winter sleep, does not diminish in weight.

MISCELLANEOUS.—The carp will certainly thrive in the interior waters of this State, with the possible exception of the lakes near the summit of the Sierra Nevada, where the water in summer may be too cold.

28. *Statement of Joseph D. Redding, Cal. Fish Commission, San Francisco, Cal., Apr.* 5, 1884.

EDIBLE QUALITIES.—A gentleman friend of mine, and quite an epicure, invited me to a carp dinner. We had carp cooked in five different ways—boiled, broiled, fried, stewed, and baked. Under the head broiled I include the method, No. 335, on page 326 in U. S. F. C. Bulletin, 1883, which was by far the most delicious. In each instance the carp were properly cleansed for a period of several days by being kept in pure water constantly changed. It is to my mind a first-class food-fish, if properly treated, and should in time become to fish what potatoes are to vegetables.

29. *Statement of Levi Davis, Forestville, Sonoma Co., Cal.*, 1883.

EDIBLE QUALITIES.—Carp is an excellent and cheap food, the quality of which I consider equal to the trout.

30. *Statement of Alfred La Motte, Sonoma, Sonoma Co., Cal.*, 1883.

EDIBLE QUALITIES.—The table qualities of the carp are good, not equal, of course, to the brook trout, but superior to most of our river fishes.

COLORADO.

31. *Statement of Addison Baker, Denver, Arapahoe Co., Colo., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—About three years ago I received 25 carp, which I placed in a natural pond on Platte River bottom. It is 800 feet long, from 50 to 100 feet wide, and from 2 to 6 feet deep, with a gravelly bottom overlaid with black muck and moss. The water in the pond is spring water, but rises and lowers with the Platte River, which is near by, and nearly 10 miles from the foot of the mountains. When the river is low I turn in water taken from farther up the stream. The temperature of the water is about 60 degrees.

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* Report California Fish Commissioners, 1880, pp. 10, 11.

PLANTS.—The pond contains numerous plants belonging to this mountain region, and also a kind of moss that grows nearly to the surface of the water.

ENEMIES.—I had sun-fish in the pond at first, but, since, other mountain fish have run in through the filling pond from the river—suckers, dace, catfish, and bull-heads. Muskrats have made considerable trouble.

FOOD AND GROWTH.—I have given the carp no food. They are now, I should think, from 6 to 8 inches long, 3 or 4 wide, and from 4 to 6 ounces in weight.

32. *Statement of J. M. Broadwell, Denver, Arapahoe Co., Colo., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—Three years ago this summer I received 5 mirror carp and 10 scale carp through W. E. Sistey. I at first kept them in a pond which was fed by an abundance of cold spring water from the bottom, and had an average temperature of about 50°. This spring I made a pond about 300 by 500 feet large, and about 3 feet in its deepest part, with warmer water and a muddy bottom, to which I removed the fish.

PLANTS.—The first pond contained but little vegetation, but in the new one there are many kinds of plants, moss, and tule [or bulrush, *Scirpus lacustris L.*], and other grasses.

ENEMIES.—There are no other fish in the pond, but some frogs.

FOOD.—I only feed them the offal from trout ponds, which is liver, lights, &c.

GROWTH.—When I moved them this spring the largest ones weighed 4 pounds and the smallest ones 2 pounds. There were 14 of the original fish left. The mirror carp were much the largest. There were but 5 young ones then, and they all seemed to be of the scale kind. They were about 6 inches long in April. I think they are doing very well since changed to the new pond, and the largest fish will weigh 6 pounds now.

REPRODUCTION.—They did not thrive in the cold water; the young seemed to hatch, but did not live. Now at the present time there are or seem to be a great many young from 1 to 4 inches long.

DIFFICULTIES.—The only difficulty was that cold water.

33. *Statement of Henry Lee, Denver, Arapahoe Co., Colo., Oct.* 5, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp in December, 1880. My pond covers 50 acres, has a muddy bottom and an average depth of 7 feet. It is filled from an irrigating ditch, has no outlet, and is of medium warmth.

PLANTS.—It contains quite a variety of aquatic plants, one of which is called "sea-weed."

ENEMIES.—The pond contains black bass and suckers.

GROWTH.—The carp are very large, but none have been caught yet. I have not fed them, nor have I seen any young.

DIFFICULTIES.—It is a large body of water, and I have not provided any means for drawing it off.

34. *Statement of George F. Wortmann, Denver, Arapahoe Co., Colo., Sept.* 17, 1883.

DISPOSITION OF CARP RECEIVED.—Three years ago I received 8 carp and put them in a pond 60 feet square, and 5 feet deep. The clear water is from a creek, and stands at from 60° to 75° in summer and freezes from 7 to 13 inches thick in winter. The first winter was so cold that it froze the little pond nearly to the bottom and killed the fish. I have built another pond of 3 acres and 6 feet deep for more carp. Some others have carp in this vicinity, but will not sell them for less than $5 apiece.

35. *Statement of J. Hetzel, Longmont, Boulder Co., Colo., July* 16, 1883.

DISPOSITION OF CARP RECEIVED.—I shipped some carp 4 inches long from California, 14 months since. The reservoir in which some of them have been kept covers 20 acres, and is from 6 inches to 4 feet deep. It has no feeders from October to April. The water froze so as to leave not over 20 inches open during cold weather. Another lake had still less, and covered no more than a quarter of an acre; still there was no loss. The bottom is composed of clay and mud. The ice was cut open every day as long as it lasted.

GROWTH AND REPRODUCTION.—We do not feed the carp, which are now 2 years old and are spawning. They measure 16 inches, and weigh 3 pounds at the present time.

DIFFICULTIES.—Some parties who did not cut the ice on their ponds in winter lost all their fish. Mr. Church, I am told, lost everything, carp and all. Others lost cat-fish.

MISCELLANEOUS.—We look forward to the time when fish in this irrigating country will be very plenty, as our reservoirs seem to be just the place for them.

36. *Statement of George De La Vergne, Colorado Springs, El Paso Co., Colo., Nov.* 18, 1880

FOOD.—My carp received no artificial food, but subsisted on the natural production of the pond.

GROWTH.—When transferred to the feeding pond, about the 20th of last May, my carp were from 1½ to 2½ inches long. On the 26th of the following July they were 7 inches long. On September 2 I transferred them to their winter quarters, and they then measured 9½ inches in length, and were strikingly plump; others had made a proportionate growth.

37. *Statement of George De La Vergne, Colorado Springs, El Paso Co., Colo., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—I received a shipment of carp in the fall of 1879, 18 of which survived, and were placed in the ponds. One pond measures 75 by 100 feet, is from 3½ to 4 feet deep, and has a sandy loam bottom. Connected with this is a pond one-third of an acre in extent and from 6 inches to 2½ feet deep, with a bottom of loam and turf. A strong spring 200 yards distant supplies the first pond, from which the water backs into the second. The temperature of the water in the ponds is 60° in summer and in winter 35°. The water freezes, but not where the supply comes in.

PLANTS.—The ponds contain Colorado wild grass, two varieties of indigenous moss, dock, rushes, &c.

ENEMIES.—There are some frogs; I sometimes kill a mud-turtle, and I am not altogether rid of suckers. A fish-hawk took one of the original fish, and one died from wounds the cause of which is unknown.

GROWTH.—They get their own food. The old ones, of which there are 16 now left, are from 18 to 24 inches long, and are bulky. They are remarkably healthy. The young vary from the size of a steel pen to 12 inches long.

REPRODUCTION.—There probably were from 1,500 to 2,000 young last spring. I think there are very many fry now.

SALES.—I sold 25 young fish last spring.

DIFFICULTIES.—The only great difficulty was the drawing down of the water and stranding of the young in the moss, weeds, &c., on the margin of the ponds.

38. *Statement of C. E. Burris, Monument, El Paso Co., Colo., Sept.* 27, 1880.

GROWTH.—The carp have done finely, increasing their size threefold.

39. *Statement of George L. Sanborn, Morrison, Jefferson Co., Colo., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—Mr. Harriman, of this place, received carp 3 years ago, which were placed in a small pond 100 feet long and 40 feet wide, fed by a springs The water is too cold for carp; the average summer temperature is 50° Fahrenheit.

PLANTS AND ENEMIES.—Grass grows on the edge of the pond and there are frog. and American carp in it.

FOOD.—The fish are fed with curdled milk.

GROWTH.—We have tried to get the original ones, but failed to find them. The young ones grow slowly on account of the water being too cold.

REPRODUCTION.—A great quantity of young have been produced, but they are mostly mixed with the American carp.

DISPOSITION OF YOUNG.—Some of the young fish have been given to neighbors who have warmer lakes, and are doing well, some of them now weighing 2 pounds.

MISCELLANEOUS.—You see that the carp have not had fair treatment. I have now a lake of 40 acres, of which the temperature is at present 80° Fahrenheit, but do not want to put in the American carp, and would like this summer or fall to get a lot of German carp.

40. *Statement of Hermann Hibschle, Leadville, Lake Co., Colo., Aug.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—In 1880 I received 8 carp, which were put into a one-acre pond from 2 to 3 feet deep, with a muddy bottom, near Denver, Colo. The pond is under the care of another man, and I suppose it is not large enough to give them full chance.

PLANTS.—The pond is full of worms and different plants of which I do not know the names.

ENEMIES.—There are no other fish or turtles, but some few frogs.

FOOD.—The carp have not been fed much. Liver and lights are all they have had so far, and only once or twice a week, and they do well with this food.

GROWTH.—The original fish weigh 8 or 9 pounds. The first young are 5 or 6 inches long, and the last are 1½ inches long.

REPRODUCTION.—It is hard to say how many young they have produced. The water is full of fish. There are four broods.

41. *Statement of John Sheldon, Fort Collins, Larimer Co., Colo., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—Two years ago last winter, I think, I received 15 very small ones from the fish commissioner at Denver. One year ago last winter I received 20 from you. I cut a hole through the ice of my lake and put them in, and have never seen one since. The lake covers about 15 acres, and is about 10 feet deep. The bottom is a dry loam, a good wheat soil, but still it will bear up a horse well, even when covered with water. Water is let in from an irrigating ditch which is 12 or 14 feet wide on the bottom, and from 2½ to 3 feet deep. There is no outlet that I now use, but I could have one if I desired.

PLANTS AND FOOD.—The principal plant is a kind of "sea-weed" that looks some like clover in its leaves. It grows nearly all over the lake and up to the surface, even in 10 feet of water. On this the fish principally feed and keep very fat.

ENEMIES.—There are in the lake sunfish, called by some rock bass, which are sweet and solid all summer and bite a hook quickly; small cat-fish, red horse, shiners, and the finest suckers I ever saw, some weighing over 4 pounds.

DIFFICULTIES.—I do not know what to expect. I am catching out sunfish almost daily, and have caught several barrels of suckers that run up the ditch to the head gate, but have seen no carp. I fear the sunfish have eaten up all the little fellows, and I should much like to have 25 carp about 6 inches long, that the other fish could not master. The former ones may be in the lake, but I suppose I would hook them out occasionally if they were.

42. *Statement of B. H. Eaton, Greeley, Weld Co., Colo., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—Over two years ago I received some carp and put them in a canal. The water was so strongly alkaline that they all died. If I can secure carp again I will put them into a lake that has had water in it for years, and now contains sun-fish and small catfish.

CONNECTICUT.

43. *Statement of Amos Stone, Danbury, Fairfield Co., Conn., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp in 1881 and put them in a nice spring-water pond with an average depth of 3 feet.

PLANTS AND ENEMIES.—It contains water-grasses and other water plants, and also trout, pike, bass, perch, and bull-heads.

MISCELLANEOUS.—I know nothing concerning the old or young, but think they will do well here. I do not feed them.

44. *Statement of Edmund O. Hurlbutt, Georgetown, Fairfield Co., Conn., Sept.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in January, 1881, and put them in a pond situated on a high hill. It covers 3 acres and is fed by springs; has a depth of from 4 to 5 feet, and is surrounded by ledge and woods.

PLANTS AND ENEMIES.—There are no fish of any kind in the pond, perhaps a bull-frog or so, but no turtles. There are also swamp grass and some weeds in the pond.

FOOD.—I feed them with corn and bread.

MISCELLANEOUS.—During my absence in the West last April the pond overflowed and the fish are probably lost. I am fitting it up again and would like another supply.

45. *Statement of Samuel J. Miller, Georgetown, Fairfield Co., Conn., July* 21, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp about December, 1880, and placed them in a small pond. A freshet overflowed the following spring and the carp probably went out, as they have not been seen since. They may still be in the river.

GROWTH.—Mr. Gilbert received 200 carp about the same time. I have heard of 3 of them being caught by hook this spring. They weighed from 4 to 5 pounds each.

46. *Statement of G. T. Osborn, Georgetown, Fairfield Co., Conn., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—About January, 1881, I received some carp and put them in a spring, 3 by 8 feet. Last summer I built a pond covering a quarter of

an acre, 3 feet deep, with muddy bottom. It is fed by a spring; is warm in winter and cold in summer. Wild grass grows in it.

MISCELLANEOUS.—Last summer I had 7 or 8 carp; but since I have built the pond I have not seen any, and do not think they have gone into the pond.

47. *Statement of John B. Knapp, Stamford, Fairfield Co., Conn., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—In October, 1880, I received about 30 carp and put them in Crystal Lake. It contains about 4 acres in winter and 1 acre in summer. Its depth is from 2 to 5 feet in winter. A good-sized brook of pure, cool, spring water flows through it.

PLANTS.—It contains coarse grass and sweet flags.

ENEMIES.—There are a great many frogs, some brook trout, and a few turtles in it.

GROWTH AND REPRODUCTION.—The old ones appear to weigh from ½ to 1 pound, and there seem to be a considerable number of small ones, which are about the size of the original ones. They have not increased in size as I anticipated. I have not taken any out nor have I fed them.

48. *Statement of Wm. T. Curtis, Stratford, Fairfield Co., Conn., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp November 8, 1880, and put them in a pond containing ½ of an acre, 6 feet deep in the deepest part, and a muddy bottom. Most of the year a small stream runs through it, and it has never been over 8 inches below high-water mark.

PLANTS.—The pond contains white pond lilies and many other plants and grasses bearing seeds.

ENEMIES.—It contains no other fish, but some frogs and perhaps turtles. During the first winter muskrats let out the water, and I suppose the young carp perished, as I have seen nothing of them since.

49. *Statement of Hon. Daniel C. Birdsall, Westport, Fairfield Co., Conn., July* 21, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp November 29, 1881, and placed them in an artificial lake, about 2 acres in area, varying from 1 foot to 10 feet in depth, with a muddy bottom. The brook running through it overflows the dam nine months of the year, and is of the usual temperature of the atmosphere. There are no water plants, grasses, turtles, frogs, nor other fish in the water.

FOOD.—From May until winter I feed the carp with garden refuse, bread, rye, and dough. In winter I give them nothing.

GROWTH.—I have seen only one of the old ones of any considerable size, and this was from 12 to 16 inches long, and evidently spawning. I have seen no young yet. I will draw off the water this fall and make a fuller report.

50.—*Statement of S. Harrison Carrington, Bristol, Hartford Co., Conn., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp, through Dr. William M. Hudson, November 4, 1880. My pond covers about half of an acre, has smooth bottom and about 6 or 10 inches of mud. A stream of pure spring water, cold enough for drinking, flows through it in quantity enough to fill a 4-inch pipe.

PLANTS AND ENEMIES.—It contains some white lilies, covering about one-third of the pond, and common grass around the edges, and also some trout and frogs.

MISCELLANEOUS.—I have never fed them and have never seen them since putting them in, but have no reason to suppose but that they are all alive. Mr. Fenton, at the State hatchery, told me that he had never seen his except the one they caught last September, weighing 2½ pounds. They were of the same lot as mine, and had only 20 inches of water over the mud, while mine have 5 feet, and he thought mine would weigh from 3 to 3½ pounds. I have tried various kinds of bait, but as yet have not been able to catch any.

51. *Statement of Chas. S. Mason, gardener of Miss Sarah Porter, Farmington, Hartford Co., Conn., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1880, I received 10 scale carp and 10 leather carp. They were placed in a pond about ½ of an acre in size, and with a depth of 5 feet in the deepest part, and a muddy bottom. The pond is fed by springs, and overflows only occasionally. In winter it freezes to the depth of a foot. The temperature July 24 was 80°.

PLANTS.—It contains white water-lily (*Nymphea odorata*), *Nelumbium luteum*, cat-tail flag (*Typha latifolia*), bulrush (*Scirpus lacustris*). Previous to the introduction of the

carp we were very much troubled with a confervæ, but since it has been steadily on the decrease. This summer it has not yet shown itself on the surface. I imagine it is in a measure due to the carp feeding on it.

ENEMIES.—The pond contains frogs, turtles, and bull-heads. The greatest difficulty has been to keep the bull-heads from eating the carp eggs. I found upon watching them that they followed the carp around, and as they seemed to be busily eating something, I concluded that the carp were spawning and the bull-heads eating up their spawn. In order to stop this, I purchased a few feet of wire netting and made a trap like an eel pot, and baited it with bread and meat. The result is that I have caught over one thousand of the depredators, thus thinning them out quite perceptibly.

FOOD.—We feed the carp on the waste from the table—such as bread, rice, hominy, oatmeal, and occasional scraps of meat.

GROWTH.—I should think the old ones are 15 inches long and weigh 4 pounds. I have counted 7 of them, and think there are more.

REPRODUCTION.—They have produced hundreds of young, which are of all sizes, from 2 to 9 inches in length, weighing from an ounce up to a pound or more. They did not spawn until late in the summer of 1881. We now have in the pond three different sizes of young carp, measuring from 2 to 9 inches in length. It is a curious fact, although we received both scale and leather carp, we have failed to find any pure leather carp among the young. There are pure scale carp in abundance and a plenty of what seems to be a cross between the two, resembling one figured in the Scientific American some time ago and called "specularis" or mirror carp. They are very handsome. One noticeable feature of these carp is their tameness during their spawning season. It was an easy matter to observe them. Since that time they have been quite shy, seldom showing themselves. Their manner of spawning seems to me to be rather peculiar. They dart in among the grass on the margin of the pond or among the water lilies or cat-tails, turning themselves on their sides and making a great splashing and commotion. In such times they go in twos and threes.

52. *Statement of Frederick Fenton, Poquonock, Hartford Co., Conn., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The carp which I received in November, 1880, I put in a pond of 50 acres, 20 feet deep, muddy bottom, and warm water.

PLANTS AND ENEMIES.—It contains water-lilies, frogs, and turtles. I let the carp seek their own food, and have not seen one since they were placed in the pond.

53. *Statement of Henry J. Fenton, Poquonock, Hartford Co., Conn., Jan.*, 1883.

DISPOSITION OF CARP RECEIVED.—In December, 1880, a few carp, from 2 to 3 inches long, were placed in a small pond near a pond in which breeding-trout were kept. The pond is not more than 2 feet deep, and at the bottom there are 2 feet of black mud.

PLANTS.—In summer the vegetable growth in the pond is abundant, and the green plant known as frog-spittle is so luxuriant as to cover the entire pond.

FOOD.—The carp have never been given any artificial food.

GROWTH.—The water was drawn August 19, 1882, and 3 of the carp were captured, the largest of which weighed 33 ounces, the smallest 21 ounces, and the third 23 ounces. On the same day a carp was taken from an adjoining pond, having been placed there in December, 1881, and found to weigh 11 ounces. While the growth of these carp is not equal to that reported from some of the Southern States, yet 2 pounds in weight in 2 years cannot be regarded as a failure, especially when it is considered that they have had no food whatever except what they have found growing in the pond.

54. *Statement of Henry J. Fenton, Poquonock, Hartford Co., Conn., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The carp I received in November, 1880, I put in a pond of half an acre, 3 feet deep, muddy bottom, through which flows a good-sized brook during the summer.

PLANTS, ENEMIES, AND FOOD.—The pond contains lilies and brook trout. The fish seek their own food.

GROWTH AND REPRODUCTION.—I have 5 of the original lot, which weigh about 3 pounds each. I have seen some young about 2 inches long, but cannot tell how many.

DIFFICULTIES.—Some of them were troubled with fungus.

55. *Statement of W. A. Stocking, Weatogue, Hartford Co., Conn., Nov.* 6, 1882.

ENEMIES.—The carp in two of the ponds were probably destroyed by the hawks and turtles.

GROWTH.—Of the carp received last year I lost all except 3. I put them in 3 different ponds. On November 4, one weighed 1¼ pounds, and measured 13 inches. I think there is no question that many New England farmers could raise carp at much greater profit than is now derived from all their crops.

56. *Statement of Hiram G. Phelps, Windsor, Hartford Co., Conn., Sept.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—I received 30 carp in 1880, and put them in a land-locked pond of 50 acres.

PLANTS AND ENEMIES.—It contains water-lilies and frogs. I let them feed themselves and have never seen one since.

57. *Statement of Caleb Leavitt, Windsorville, Hartford Co., Conn., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received 30 fish about two years ago and put 15 in each of 2 ponds. One pond, 10 by 15 rods, became dry, and the fish all died. The other pond, 30 by 40 rods, is fed by springs. No stream flows in nor out.

PLANTS.—The pond contains water-grasses and yellow water-lilies, and other common pond grasses.

ENEMIES.—It also contains bull-heads, frogs, and turtles. Turtles I have never seen, but presume they are there.

MISCELLANEOUS.—I have not fed them, and do not know whether they have spawned or how many there are left.

58. *Statement of D. F. White, Derby, New Haven Co., Conn., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—In February, 1881, I received 15 carp in bad condition, and only 9 lived. These are still alive. The pond they were kept in is fed by a spring; is 4 feet deep, and has a muddy bottom. It is 30 by 100 feet in dimensions, and at present is a perfect mass of pond-lilies. Last fall I built a more extensive pond with abundance of water. It does not freeze. It has no frogs, and is a perfect carp heaven.

GROWTH AND REPRODUCTION.—The carp will now weigh 3½ pounds each. I do not know that I have seen any young yet; there may be many. From not being fed they are very shy, and when there is nothing else to protect them from view they have a very handy way of using the muddy water for that purpose. I have seen no young, and the frogs may have eaten up the eggs. I have never fed them.

59. *Statement of Harvey S. Hall, Wallingford, New Haven Co., Conn., Oct.* 9, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in November, 1880, and put them in a large pond newly made. In February, or March, 1881, a large freshet carried away the dam and all the fish. I now have 3 ponds connected and supplied with 1,000 gallons of water daily. Their average depth is 3 feet, and the temperature in summer 75°.

PLANTS AND ENEMIES.—They contain flags and coarse grass, and no enemies but frogs. I would like some more carp.

60. *Statement of J. A. Ayres, Mystic River, New London Co., Conn., Aug.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—I received about 20 carp two years and a half ago. I put them in a green-house tank the first winter, where they nearly all died. The one that was left in the spring I put in my pond, which is 100 feet in diameter and 6 feet deep. A little water flows through it, which is very warm, and the bottom is muddy.

PLANTS AND ENEMIES.—It contains all the water plants and grasses common to this section, as well as gold-fish and eels, frogs and turtles, and the abominable spawning toad, which is my chief nuisance. I have furnished no artificial food.

GROWTH.—The one carp which I have left is now 22 inches long, and I estimate that it weighs 6 or more pounds.

61. *Statement of Leonard V. Greene, Norwich, New London Co., Conn., Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in November, 1880, and 20 more in November, 1881. My pond covers one-half of an acre, averages 4 feet in depth, and has a bottom of clay, mud, and stone. It is supplied by a spring, and the temperature is 75°.

PLANTS.—It contains *sagittaria*, *typha latifolia*, and a fine grass growing on the bottom. A plant with branches of small oval leaves floating on the surface.

ENEMIES.—It also contains frogs and roaches. The latter are very troublesome.

FOOD.—I feed them but little, and then mostly on green corn. I sometimes have given them bread.

GROWTH.—Last October I had 12 left of the 1880 lot. These average from 2¾ to 3 pounds each. I have 14 left of the scaleless carp received in 1881, which will average 1 pound each.

REPRODUCTION.—The young which I have taken this season weigh from 2 to 4 ounces each. I cannot say how many young have been produced. They have not spawned this season up to July 29.

MISCELLANEOUS.—I sent E. W. Williams, of Yantic, 12 carp, old and young, in October, 1882. I think, with plenty of food, carp will make much greater growth than any fish we have. In cool water I expect to find the flesh firmer. I hope to distribute some to ponds in the neighborhood this fall.

62. *Statement of W. H. Siems, West Chester, New London Co., Conn., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—Two years next November I received a can of carp and put them in a pond prepared expressly for their reception.

GROWTH.—On drawing the pond in May, 1883, to ascertain my success, I found 5 carp, one of which weighed 4½ pounds. I have not seen the other 4 since, nor have I discovered any spawn in the pond.

EDIBLE QUALITIES.—I have eaten carp in Germany and know their value as a food-fish.

FUNGUS.—In May I also saw 2 large fish with white spots on their backs as large as a silver dollar. Our fish commission claims this to be a fungous growth, which will destroy the carp.

DELAWARE.

63. *Statement of William George Hill, Clayton, Kent Co., Del., Sept.* 30, 1882.

GROWTH.—I find the 3-inch carp put in my pond last fall to be over 18 inches long, and one to weigh over 2 pounds. They exceeded all my expectations. Some of them are scale carp and some mirror carp.

64. *Statement of Zebulon Hopkins, Farmington, Kent Co., Del., Aug.* 1, 1883.

DISPOSITION of CARP RECEIVED.—I received 4 dozen carp in December, 1880, and put them in a spring pond, but it was a failure.

65. *Statement of T. B. Coursey, Frederica, Kent Co., Del., July* 25 *and Nov.* 5, 1883.

DISPOSITION OF CARP RECEIVED.—I received about 40 carp in the spring of 1881, and have received 25 since then. My first pond covered about ⅛ of an acre, was from 1 foot to 3 feet deep, with muddy bottom predominating. There is water enough flowing in to fill a 2-inch pipe under a pressure of a foot head. In 1882 I made a new pond of about 1 acre area and from 1 foot to 5 feet deep, to which I transferred 20 of the carp in August, 1882, leaving a few in the first pond. In September there came a freshet and high tide, which overflowed the banks of the first pond nearly a foot and of the new pond several inches. All of the carp left the first pond and went into the creek. Subsequently the bank of the new pond gave way (undermined by musk-rats), thus letting out all but 2 feet of water in the deepest place. Some of the carp may have remained there, but of those escaping 5 lodged on the flats, which I secured and put in a temporary place until spring, so as to let the banks of the pond settle and become secure.

ENEMIES.—The pond contained a few sunfish, minnows, and frogs. Minks in the vicinity have preyed upon them.

FOOD.—I gave the carp no food the first 6 months, but since then have given them scraps once a day. They now come to be fed every evening like chickens, and tumble about in the water for the scraps of bread like young porpoises.

GROWTH.—One of the carp received in March, 1881, grew in 5 months to a length of 12½ inches without any food other than that found in the water. August 24, 1882, I had 18 of the original carp, some of them then 16 inches long and weighing 14 ounces. In November, 1883, some of the carp weighed 3 pounds each. I have 24 beauties left.

REPRODUCTION.—August 24, 1882, I found a number of young. This was more than I anticipated, as I did not expect any until the following year.

MISCELLANEOUS.—I think the creek will be stocked with them and be well adapted to their growth. A neighbor living about a mile down the creek caught in his shad seine one which weighed 3 pounds. He ate it, and pronounced it a good fish.

66.—*Statement of S. H. Wilson, Greenville, New Castle Co., Del., Dec.*, 1882.

DISPOSITION OF CARP RECEIVED.—The 20 carp, about 2½ inches long, received in the fall of 1881, I placed in my pond, 30 by 50 feet, with 3½ feet of water in the deepest part. It was built originally for an ice pond, and is supplied by a small spring. It has an overshoot in case of floods.

FOOD.—I did not feed nor see them for a year.

GROWTH.—November 14, 1882, I drew off the pond and found 10 fish, the largest measuring 15 and the smallest 11 inches in length. I am very well satisfied, and shall build another pond this winter.

67.—*Statement of Samuel N. Trump, Wilmington, New Castle Co., Del., Jan.*, 26, 1883.

DISPOSITION OF CARP RECEIVED.—My pond is only about 40 feet in diameter, in a low place, supplied with spring water. The spring water is a detriment, as it keeps cool and the fish do not grow so fast. About 2 years ago I placed 20 carp, then 9 months' old and measuring about 3 inches in length, in this pond, and subsequently others were put in from time to time.

PLANTS.—The pond is well filled with vegetable growth, common in this part of the country, and there are no conditions other than are found in most ditches and ponds throughout the State.

FOOD.—Little or no attention has been given to them, except to occasionally throw in a handful of stale bread or cake made of corn-meal and flour. I considered a little artificial food needful, because of there being too many fish for the pond, the original 20 being sufficient.

GROWTH.—The largest fish now measures about 16 inches and the smallest about 10 inches in length. I have not weighed any of them, but should judge they would weigh from 1 pound to 1½ pounds each; this, however, is a mere guess, they may weigh more.

MISCELLANEOUS.—I have not a doubt that my carp would have been double the size, by this time, with warmer water, or water supplied from a brook and more exposed to the sun, more food or fewer carp. I am particularly interested in the culture of fish, because I think them an excellent and wholesome food. I believe they may be produced here in unlimited quantities, becoming a cheap and valuable food, and a source of revenue from spots which are now regarded worthless.

68. *Statement of George M. Outten, Concord, Sussex Co., Del., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—Two years ago last spring I received 20 carp, and later a few from a neighbor's pond. My pond covers one-half acre, has a depth of from 2 inches to 4 feet, and is amply supplied with water, which is continually changing. Its temperature is 84°.

PLANTS.—There is a good supply of what is commonly called tuckahoe and several grasses.

ENEMIES.—There are a few pike, which we have been trying to catch out.

FOOD.—Believing the pond to contain an abundant supply of food, we have not fed them regularly.

MISCELLANEOUS.—We occasionally see 2 or 3 at a time of about the size of common herring, and do not know whether they have spawned. We take pleasure in watching their gambols.

69. *Statement of G. W. Horsey, Laurel, Sussex Co., Del., Aug.* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I have received carp 2 or 3 times. My pond is 15 by 40 feet, hard bottom, and fed entirely by a spring. The water is 2 feet deep, very clear and pure. There are no fish in it now. I do not know what became of the carp, but would like some more.

70. *Statement of John N. Wright, Oak Grove, Sussex Co., Del., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received 18 carp in the fall of 1881, and 30 more in November, 1882. I put them in a small pond covering 30 acres, from 4 to 9 feet deep, with muddy bottom. There is water enough flowing through to run a water-wheel for a saw-mill 8 months in the year.

PLANTS.—There is plenty of grass in the pond.

ENEMIES.—There are turtles, terrapins, pike, catfish, mullet, sunfish, and eels in the pond.

MISCELLANEOUS.—I have not seen any carp since I put them in, though I have looked a number of times. Still, I believe there are carp there, and that I have not seen them on account of the largeness of the pond.

71. *Statement of Hon. E. L. Martin, Seaford, Sussex Co., Del., Dec.* 28, 1882.

DISPOSITION OF CARP RECEIVED.—About three years ago I received 250 scale carp, 200 of which I placed in a mill-pond, and the remaining 50 in a pond near my barn, and which receives the drainage from my premises.

GROWTH AND REPRODUCTION.—About the first of May of the second year, early one morning, I was agreeably surprised to find my pond alive with fish nearly as large as shad. They were in the act of spawning, which was repeated two or three times at intervals of a week or ten days. About ten days thereafter I found thousands of little fish, barely discernible to the naked eye. In the fall, after a long continued drought, my pond nearly dried up, and I was compelled to confine the water to narrower limits and by so doing was enabled to get hold of my fish and count and weigh them. I had 33 of the original plant left, the heaviest one weighing 3 pounds and 10 ounces. I have no means of knowing how many I have in my pond now, but I have them weighing at least 5 pounds.

DISPOSITION OF YOUNG.—I took from the pond at different times and placed in other streams about 15,000 young ones during the season, some of which had attained a length of 4 or 5 inches.

EDIBLE QUALITIES.—Last spring some of our fishermen caught one in a shad seine, which weighed 3½ pounds, being then only two years old. My brother, Dr. Martin, bought the fish, which remained alive out of the water 5 or 6 hours, had it boiled and dressed similar to boiled rock, and a number of our epicures in fish who partook of it pronounced it very little, if any, inferior to the rock.

DIFFICULTIES.—I left about 5,000 or 6,000 young ones in the pond, which was a great mistake, as there was not sufficient food to sustain so many. The result was, it retarded the growth of the larger ones, and also the young ones, and nearly destroyed all the young spawn the succeeding year. About two years ago I placed some leather carp in a small pond on a meadow, intending them for distribution in the spring. But before I got to distribute them a heavy gust-tide overflowed the meadow and the most of the fish escaped to the river.

MISCELLANEOUS.—From my experience, I am satisfied we have all the conditions necessary for successful carp culture in our ponds and streams on this peninsula, and it requires only a very little intelligent care to make it a profitable business.

DISTRICT OF COLUMBIA.

72. *Statement of Rud. Hessel, United States Carp Ponds, Washington, D. C., Sept.* 25, 1883.

ENEMIES.—During the past few days a great many snakes have appeared at the ponds, many of which have been killed, as follows: August 4, 16; August 5, 32; August 6, 52; August 7, 32; August 8, 39; August 9, 14; August 10, 15; August 11, 21. This makes 221 snakes killed in one week.

In the smaller snakes I found from 9 to 15 young carp, and in the larger ones sometimes over 25, besides undigested skeletons of fish. They contained no frogs nor tadpoles. We can, therefore, see that one medium-sized snake devours 40 young carp per day, for they digest very quickly. That would make, for 225 snakes, 9,000 carp per day, and 63,000 per week. That number is correct, sir; and it shows that snakes are more injurious than cranes, herons, and other birds.

I kill them by shooting, oftentimes seeing only a small part of the head in the water, or hiding beneath water plants. I have had opportunity to see how they catch the young fish, and how they devour them. An old wall constitutes their best hiding place. I often shoot them sitting in the cracks of the old wall, the head looking outside, watching the poor little fishes.—*August* 12, 1883.

August 15 and 16, I did not kill any snakes, by reason of the low temperature and rain. On the following days I killed 72; August 17, 52; August 18, 7; August 19, 8; August 20, 5.—*August* 20, 1883.

The snakes, so numerous in the ponds for some time past, have almost wholly disappeared. During the past five days I shot only 3, though watching closely for them. Since July 1 we have killed over 900, mostly by shooting.—*August* 26, 1883.

During the past week I killed about 150 snakes in the west pond. To-day I killed 19. All had young carp in their stomachs.

In July, 1883, I shot a marsh hen with 38 young carp in the stomach, and a night heron containing the heads of 78 young carp.

73. *Statement of Elliott Jones, Arsenal Grounds, Washington, D. C., November* 10, 1880.

GROWTH OF CARP.—Our pond at the Arsenal was drained between the 23d and 25th of last month, and I give the respective weights of the 15 original scale carp that were taken out: 3½, 3¼, 2$\frac{15}{16}$, 2$\frac{11}{16}$, 2$\frac{10}{16}$, 2$\frac{10}{16}$, 2$\frac{10}{16}$, 2$\frac{9}{16}$, 2½, 2½, 2½, 2¼, 2$\frac{1}{16}$, 2$\frac{1}{16}$, and 2 pounds. This gives a total weight of 38$\frac{11}{16}$ pounds, and an average weight of 2 pounds and 9½ ounces.

REPRODUCTION.—The 1,612 scale carp of last year's spawning weighed from 5 ounces to 1 pound each. The number of carp hatched this year is 5,700.

MISCELLANEOUS.—A peculiar circumstance attending the draining of the pond was the absence of strange fish. Last year and the year before hundreds of strangers, such as catfish, sunfish, perch, eels, frogs, &c., were found, whereas this year we found but 2 perch, 1 eel, and 1 frog, all the others being carp. I cannot account for this circumstance, as no screen was placed over the supply pipes. The large carp appeared to have gained very little in weight during the year.

74. *Statement of Elliott Jones, Arsenal Grounds, Washington, D. C., June* 2, 1881.

DISPOSITION OF CARP RECEIVED.—The 1-acre pond at the Arsenal was completed in the fall of 1877, and in May, 1878, I placed in it 48 of the scale carp imported from Germany and measuring from 3 to 4 inches and weighing perhaps as many ounces. A second, pond, covering $\frac{1}{2}$ acre, was constructed in July, 1880, and in this I put 6 leather carp, weighing from $1\frac{1}{16}$ to $2\frac{1}{16}$ pounds.

GROWTH AND REPRODUCTION.—The 1-acre pond was not drained until May, 1879, when it was found that the carp had grown wonderfully in size, having attained a length of from 10 to 15 inches and a weight of from 2 to 3 pounds each in one year. Half of these fish were placed in the Monument ponds and the other 24 replaced in the Arsenal pond.

In November, 1879, the pond was again drained and 6,054 young taken out with the 24 breeders, which now weighed from $2\frac{1}{4}$ to $4\frac{5}{16}$ pounds. Two thousand and nineteen young, with 18 original carp, were replaced in the pond. I drained the large pond again in October, 1880, and found that the original carp had increased little in weight, though the carp spawned the previous year had attained a weight of from 5 ounces to $1\frac{1}{4}$ pounds. Six thousand four hundred and forty-two young carp were taken out, and all but 5,700 and the several hundred lost by careless handling were replaced in the pond. The small pond has never been drained yet. According to my records, the following fish should now be in the ponds, exclusive of the young fish spawned this season: In the large pond, 15 scale carp (breeders), weighing from 2 to $3\frac{1}{2}$ pounds, and 1,422 scale carp (spawn of 1879), weighing from 5 ounces to $1\frac{1}{2}$ pounds: in the small pond, 6 leather carp (breeders), weighing from $1\frac{1}{16}$ to $2\frac{1}{16}$ pounds, 294 scale carp (spawn of 1879), and 62 mirror carp (spawn of 1879), weighing about 5 ounces each.

DISPOSITION OF YOUNG.—Of the young of 1879 there were 4,035 distributed to various parties, and 5,700 young of 1880 were placed in the Monument ponds.

DIFFICULTIES.—Three of the original carp were lost by jumping out of the tank when I drained the pond in November, 1879. When the pond was drained in October, 1880, 3 original carp were missing, and several hundred young lost by careless handling.

75. *Statement of Thomas P. Morgan, Washington, D. C., April* 21, 1884.

CARP IN THE POTOMAC.—A carp weighing from 12 to 14 pounds was captured a few days ago in the Potomac River, near the mills, above the Aqueduct Bridge. It probably escaped from the Government carp ponds at the time of the flood in 1881.

76. *Statement of A. S. Pratt, Washington, D. C., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp I received in May, 1881, and the 20 in 1882, I put in my pond at Rock Enon Springs, Frederick County, Virginia.

ENEMIES.—The muskrats have so cut holes in the banks that all the young have escaped into a mill-pond.

FOOD.—The carp in the mill-pond receive much refuse from the hotel. There are still some old carp in the pond.

77. *Statement of John A. Ryder, Washington, D. C., Nov.* 27, 1883.

CARP CARNIVOROUS.—The carp examined to-day was found to contain ripe milt with active spermatozoa. About a dozen small fish were taken from the intestine, each one about an inch to $1\frac{1}{2}$ inches long when alive. They seemed to be young percoids, or some small fresh-water fish.

78. *Statement of Charles W. Scudder, Washington, D. C., Jan.* 4, 1884.

VITALITY.—Wishing to examine some scale carp anatomically, on January 2d I visited the central hatching station of the United States Fish Commission in the Armory building, and called for dead carp, as they would answer my purpose as well

as live ones. Mr. J. E. Brown handed me 7 or 8, which were from 1 inch to 3 inches in length, and which had been thrown out of the tanks as dead. These I at once put into an envelope, and carried home in my pocket.

At least an hour later I removed them from the envelope and put them in a wash-bowl of water for cleansing them. I soon noticed that two of them were floating on their sides and occasionally gasping. A half hour after this, for the purpose of discovering how much vitality there might be in the two in which I had observed signs of life, I placed in the mouth of each one a drop of brandy diluted with an equal quantity of water. These I returned to the bowl, and paid no further attention to them until 6 hours afterwards. I then noticed that the two which had received the tonic showed a marked improvement, and were swimming on their sides nearly at the top of the water. I then changed the water and administered the same amount of brandy as before. On the following morning, 13 hours after the first administration of brandy and 7 hours after the second dose, the two fish in question were apparently fully restored, and were swimming naturally and actively about the bowl. The restoration proved to be complete.

79. *Statement of Chas. W. Smiley, Washington, D. C., April* 30, 1884.

Resuscitation of frozen carp—On the morning of January 4, 1884, 2,100 German carp were forwarded from Washington, by express, to Birmingham, Ala. Mr. F. L. Donnelly, a messenger of the Commission, proceeded by the same train to watch them on their passage and to take charge of them upon their arrival at Birmingham. The fish had been placed in the usual four-quart tin pails, and packed in crates of 16 pails each. Each pail contained 15 carp.

Mr. Donnelly and the carp arrived at Birmingham at 1.30 a. m., January 6. The packages were left in the office of the Southern Express Company through the remainder of that night, but placed within 10 feet of the stove in order to prevent the water freezing. The thermometer indicated +4° F. at the time of arrival. At 8 o'clock on the morning of the 6th Mr. Donnelly examined the condition of the fish, and, in his official report dated January 14, says:

"I was greatly surprised to find every drop of water in the buckets frozen into solid ice, and all the fish apparently dead; but upon close examination of their eyes, I thought perhaps a great many of them were still alive, though frozen solid in the ice."

Mr. Donnelly thereupon courageously undertook to see if any of the fish could be saved. He procured the necessary laborers, 4 large tubs, and a supply of water. He then broke the ice from the small pails, transferring such as contained carp to the water. He states that "in this manner a great number of fish were soon freed from their confinement, and by constant working with them during the entire day we were able to save 1,300 fish." Although the thermometer continued to remain in the vicinity of zero, by careful management he succeeded in keeping the 1,300 fish alive until the 8th and 9th, when they were distributed to the applicants throughout the State.

The saving of 1,300 carp out of a lot of 2,100, under such circumstances, may be considered a very remarkable achievement.

Having prepared the foregoing statement from Mr. Donnelly's report, I sent a copy of it to Mr. L. H. Black, route agent, Southern Express Company, Montgomery, Ala., asking how far he knew the statements to be true. Under date of January 25, 1884, he wrote me in reply as follows: "As route agent of the Southern Express Company, my duties call me to Birmingham. I saw the carp first on the morning after their arrival at Birmingham, and frequently during the day while Mr. Donnelly was at work with them. My opinion is that this statement is correct in every particular. I give it from what I saw myself, and from information Mr. Donnelly gave me during the day while he was working with the fish."

Carp in Ogeechee River.—April 14, 1884, Mr. George A. Hudson, of Savannah, Ga., sent to the National Museum some small fish which had been caught in the fresh water of the Ogeechee River in a trap set for herring, rockfish, &c. They were sent for identification, and proved to be German carp.

FLORIDA.

80. *Statement of John A. Henderson, Tallahassee, Leon Co., Fla., July* 25, 1883.

Disposition of carp received.—I received about 40 carp in January, 1881. My pond covers 10 acres; is 10 feet deep and has a clayey bottom. The water is from 40° to 90° temperature, according to the season.

Plants.—It contains grasses and bonnets.

Enemies.—There are none that I know of.

MISCELLANEOUS.—The carp were subjected to a severe change of temperature when they were placed in the pond, and are not known to have survived. I am making arrangements to get another supply from Rixford, Fla.

PROPAGATING BRIM.—I once stocked an adjoining pond of about 30 acres with a native fish called "brim," and have been very successful in raising large quantities of very fine edible fish.

81. *Statement of Henry Foster, Oviedo, Orange Co., Fla., Feb.* 15, 1882.

ENEMIES.—A white heron was seen to catch the large carp, and the little fellows may meet the same fate when they get large enough.

82. *Statement of L. Johnson, Sorrento, Orange Co., Fla., Apr.* 23, 1883.

GROWTH.—The 8 carp which I placed in my pond 2 years ago I did not see for the space of 14 months. They now measure fully 28 inches in length. I have been unable to see more than 1 carp at any one time. There are no other fish in the pond.

83. *Statement of Geo. C. Rixford, Rixford, Suwannee Co., Fla., July* 17, 1883.

DISPOSITION OF CARP RECEIVED.—I received 75 carp November 26, 1879, and 20 more January 1, 1883. My pond covers about three-fourths of an acre; varies in depth from 2 to 25 feet, has a muddy bottom, and is fed by springs. There is no visible outlet, and the water is always warm.

PLANTS.—It contains water-lilies and grass.

ENEMIES.—It had black bass in it, but I have captured nearly all of them. There are small perch and minnows that I cannot get rid of.

FOOD.—I have daily given them bread made of one-third wheat-bran and two-thirds corn-meal.

GROWTH.—I presume there are 50 or 60 yet of the original lot, weighing from 6 to 10 pounds each.

REPRODUCTION.—They have not produced a single young fish, so far as I can ascertain, and I have watched them closely.

HYBERNATION.—They have never gone "into kettle," but always come for their food regularly summer and winter. They never neglected their food nor came near the shore with but one exception. That was for a day or two last year, when pursuing one of their number that had probably been bitten by a turtle. They grew nicely, and I have taken much pleasure in feeding them and in watching their movements.

DIFFICULTIES.—I am considerably disappointed at their failure to propagate. I thought I had found a fish well adapted for Florida waters. I find, however, that the black bass comes nearer filling the want. The troubles I have had to contend with are an impossibility to keep the pond clear of turtles, minnows, and small perch, which prey upon the eggs and young. Most of the ponds in Florida are not susceptible of being drained so as to get rid of them. The small fish, minnows and perch, being the natural food of the bass, he takes care of himself and protects his young.

MISCELLANEOUS.—The carp are quite tame, and when they find that I am at the feeding place they come as quickly as a drove of pigs would for corn.

GEORGIA.

84. *Statement of William S. Brantly, Macon, Bibb Co., Ga., Oct.* 1, 1882.

DISPOSITION OF CARP RECEIVED.—I received 16 leather carp November 6, 1879. I received 25 scale carp January 13, 1880, and since then I have received about 25 more leather carp. The first lot I put in a pond 20 by 60 feet, from 4 to 4½ feet deep, with muddy bottom. The second lot I put in a pond 40 by 70 feet, about 6 feet deep, with muddy bottom on one side and sand and gravel on the other. There is a flow of water through the ponds from November to June of about 2 inches, and from June to November of about one inch. October 1, the temperature of the water was 74°, but the weather is unusually warm for this month.

PLANTS.—It contains water moss, cat-tail, marsh grass, &c. I am also planting a water-lily called "bonnets."

ENEMIES.—The pond contains a destructive little minnow called top waters, large green frogs, an occasional turtle, and a few water moccasins. The minnows and frogs have been very troublesome, and seem irrepressible. I did not think, until this year, that frogs would destroy spawn. The turtles and water moccasins I can catch and kill out. I keep a turtle trap set all the time.

FOOD.—I give them refuse fruit, vegetables, bread, corn-meal, and mulberries and

blackberries, of which they are very fond. They are also very fond of grits, cow peas, and Irish potatoes cooked. I have fed them irregularly, perhaps three times a week.

GROWTH.—Of the first lot I lost all but one. This leather carp, by actual measurement, was $22\frac{1}{4}$ inches in length and $14\frac{5}{8}$ inches in circumference, April 1, 1882. I replaced it in a pond with a younger lot. I saw a number of my scale carp on April 9, 1882, that appeared to be from 12 to 18 inches in length, as they were floating upon the surface of the water. They are lively and beautiful. The second lot have all lived, and are doing well. Yesterday I weighed 2 of them which were from 20 to 21 inches in length and from 12 to 14 inches in circumference; they weighed $3\frac{1}{2}$ and $4\frac{1}{2}$ pounds, respectively.

REPRODUCTION.—The second lot produced several hundred young last year. These are now from 8 to 10 inches long, and weigh from $\frac{3}{4}$ of a pound to $1\frac{1}{2}$ pounds each. There are no young this year, and I can attribute it to no other cause but the frogs eating the spawn.

I drew off the water from the second pond last year and took out 200 of the young, then from 4 to 5 inches long, and placed them in a pond (number 3) which covers about half an acre and from 3 to 14 feet deep, with a muddy bottom.

EDIBLE QUALITIES.—I have also eaten a few fried, boiled, and dressed with egg and butter sauce and parsley. The boiled were the best, their flavor being fine and next to shad. They are probably more like our red-horse. As table fish, they are good.

DIFFICULTIES.—There have been no difficulties except with the minnows and frogs. There has never been a sick or a dead one found. From some unknown cause this year I lost nine large ones out of pond number 2, where I had placed 25 select ones for breeders.

MISCELLANEOUS.—I am delighted at the prospect, especially as I find that within 3 years I can raise leather carp of the large size of the one I now have.

85. *Statement of W. B. Chapman, Macon, Bibb Co., Ga., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received 90 carp in January, 1881, and some since then. The pond in which they were placed covers $\frac{1}{4}$ of an acre. It is 4 feet deep and muddy. The water quite cold, and is supplied from 2 cold springs. I have had some trouble to keep the dam from breaking.

PLANTS.—There are willows growing around the pond and also some swamp-grasses.

ENEMIES.—There are no frogs nor turtles in it; and no other fish except a few minnows.

FOOD.—I feed the carp twice a week with bread.

GROWTH AND REPRODUCTION.—I caught one 2 weeks ago that weighed 5 pounds and saw some that were larger. They have had several thousand young ones which are about as large as your finger.

STREAM STOCKED.—I have put some of the young in Stone Creek, near me.

86. *Statement of H. B. Davis, Macon, Bibb Co., Ga., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—Four years ago last February I received from 12 to 20 carp, and a few subsequently. Some were scale carp and some leather carp. The ponds are from 3 inches to 3 feet deep, and are supplied with 2 gallons per minute of cold, clear spring water.

I constructed my first fish-pond in February, 1879. For this purpose I drained a valley below a spring of water, clear as crystal, and which flowed into a small creek. I left a portion of the undergrowth for shade and feeding-ground. I put the first carp into this pond. Subsequently I built two ponds on the small stream, both fed from a cold clear spring; the upper was a small deep one, and the lower pond covers a considerable space, though very shallow, not averaging more than 15 inches in depth. The bottoms of these ponds are partly sand on the edges and in the center black mud, or swamp muck. Both these ponds, as in the case of the first, are only partly cleared of trees and bushes.

In the latter part of February, 1882, I constructed a fourth pond some distance from the others, which were near my house. It covered more space than any of the others, but was very shallow, not over 6 inches deep in the deepest part. I transferred six carp from one of the old ponds to this new pond, and in addition put in 160 bream.

PLANTS.—The ponds contain numerous kinds of plants and grasses, of which I do not know the names.

ENEMIES.—There are no other fish, but a few frogs and a few small turtles. I have had much trouble with snakes, turtles, and terrapins.

FOOD.—The fish in the small, deep pond were fed last year, while those in the pond below, where the fish grew to more than twice the size, had not been fed.

GROWTH.—I have 3 old ones left. They are each about 2 feet in length, and I suppose they will weigh 5 or 6 pounds. I examined one of the young ones, 15 months old. It weighed 2½ pounds, and measured 17½ inches.

REPRODUCTION.—My old carp spawned when 2 years old (June, 1881). I do not know how many young they have produced, as my pond broke and I lost many. I secured between 200 and 300.

SALES.—I sold some of the young at $5 per dozen.

EDIBLE QUALITIES.—They are not full of bones, and do not taste of mud, as some would have us think, but, on the contrary, are very free from small bones, and are a most excellent table fish, to which several who have dined with me will testify.

DIFFICULTIES.—The dam broke in June, 1880, and I lost all except five, four of which were scale carp. The 5 fish then averaged 11 inches in length. They were about 3 inches long when received three months previously. June 1, 1881, I examined the pond which had contained the five carp. Only four large carp were found, three scale and one leather. These measured 18 inches in length. In April, 1882, I examined the 2 ponds built on the small streams and discovered a great difference in the growth of the fish in the two ponds, and yet it was the same water and the same kind of bottom. The fish in the small deep pond were only 6 or 7 inches in length, while those in the pond below, covering about twice the space, were 12½ inches long.

MISCELLANEOUS.—When in 1882 I examined the pond into which I had put the carp and bream, I was surprised at the large growth of the carp as well as the slow growth of the bream. The largest of the six carp, now one year and three or four months old, measured 17 inches in length and weighed full 2½ pounds. The bream were only a little larger when put in. But there were plenty of small bream.

My conclusions as to carp are that in southern waters it makes no difference whether the water is clear or muddy; that if they have plenty of feeding ground, it is not necessary to feed them; that they do not "kettle" in winter in this latitude; and that they will certainly spawn in two years if properly cared for.

87. *Statement of J. F. Hanson, Macon, Bibb Co., Ga., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 fish about 3 years ago, and put them in a large cistern 75 feet in diameter, used as a reservoir for spring water. About 10,000 gallons a day, at a temperature, say 68° to 70°, flow through it.

PLANTS.—It contains moss and weeds, growing in the water which is perfectly clear.

ENEMIES.—There are toads sometimes found in it, and a few sun perch.

FOOD.—We fed the fish with cracked Indian corn and with plain corn bread.

DIFFICULTIES.—In a short time after we received them they disappeared, and I cannot tell what became of them. I never found any of them dead. I think the water was too cold and too clean.

[No trouble arose from the water being clean. But to transfer the fish from warm water suddenly to cold water would be so violent a change of temperature as to injure them. They would then become a much easier prey to enemies or perhaps die anyway. Carp can be transferred to icy cold water if the transition is made very gradually.—EDITOR.]

88. *Statement of Charlie Herbst, Macon, Bibb Co., Ga., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received 5 or 6 carp 2 or more years ago. Since then a few were given to me. I only have 2 now, and these I bought. I keep them in a glass tank, with a capacity of about 22 gallons, in which their shape and color are clearly seen. I change the water weekly, and handle the fish with a net.

ENEMIES.—It contains goldfish and small terrapins, known in the local lingo as "cooters." [Small water terrapins.]

FOOD.—I give them corn muffin and boiled rice.

89. *Statement of I. C. Plant, Macon, Bibb Co., Ga., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received my carp 2 and 3 years since; about 50 each year. I kept them at first in a pond covering about a half acre. I now have one 80 by 125 feet, inclosed by a board fence, to keep turtles, snakes, frogs, &c., out. There is a constant stream from dozens of springs on the edge of the largest pond, giving a stream say 10 inches in diameter that passes from the pond all the time.

PLANTS.—The ponds are shaded by willows, bays, and other small shrubs usually found around Southern ponds, and contains pond-lilies and dozens of kinds of water plants and grasses.

ENEMIES.—The only trouble which I have had in raising carp has been from turtles and frogs, which seem to eat up all the eggs. I lost thousands of fine fish the first 2 years in my large pond, they being destroyed by turtles.

FOOD.—I feed them with grits and refuse from a flouring mill near by, taken from the stones after grinding wheat, rye, and corn.

GROWTH.—I have a large portion of the original number left. They are large, plump fish from 12 to 25 inches long. The young ones are from a half inch to 5 or 6 inches long.

REPRODUCTION.—There are many thousands of young, though I lost a great many from the turtles eating them during the first two winters. They are all in the inclosed pond, as it is useless to try to raise fish in one which turtles and snakes can enter.

DISPOSITION OF YOUNG.—I have given away a large number to friends in this section of our State.

90. *Statement of Samuel M. Subers, Macon, Bibb Co., Ga., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received 18 scale carp on the 10th of January, 1880, and 22 leather carp in September, 1882. I have kept them in a pond 50 feet long and 40 feet broad, with a depth varying from 18 inches to 5 feet. The bottom is composed of mud, and six springs rising through it supply the water.

PLANTS.—There are no grasses in the pond. The willow and mulberry trees and Bermuda grasses on the banks send their roots into it.

ENEMIES.—It contains bream, sun-perch, and green frogs.

FOOD.—I feed my fish on house-flies and crackers.

GROWTH AND REPRODUCTION.—Those that I have caught weighed from $3\frac{1}{2}$ to $4\frac{1}{2}$ pounds. I cannot tell how many of the original ones I still have. I have never found but 4 of them dead. There are no young that I have seen.

DIFFICULTIES.—I think the spawn has been destroyed by other fish, &c. I do not think they increase in small ponds as rapidly as they would in large ones.

91. *Statement of E. Witkowsky, Macon, Bibb Co., Ga., Dec.* 9, 1880.

GROWTH.—I cleaned out the pond in my tan-yard November 11 to ascertain what growth the 4 carp had made which I placed there in May, 1880. I found 3 of these fish and to my astonishment they were by actual measurement 20, 22, and 25 inches in length, respectively. The fourth carp escaped through a cut in the bank. These carp were but 2 or 3 inches long when put in the pond and their growth is remarkable.

92. *Statement of Christopher and Roberts, Fairburn, Campbell Co., Ga., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—We received 8 carp December 16, 1879, and 6 more November 22, 1880. We put them in a pond covering about $\frac{3}{16}$ of an acre with a depth of from 2 to 6 feet, and with a bottom partly mud and partly blue clay. A small continuously flowing stream of comparatively warm water flows through it.

PLANTS.—It contains "swamp-grass," a very common grass in all marshy places.

ENEMIES.—It contains no other fish, no turtles, and but a few frogs.

FOOD.—We feed the carp once a day on bread and crackers, refuse from our store.

REPRODUCTION.—Our carp have spawned twice.

GROWTH.—April 22 last the pond was broken by a heavy rain and all the carp turned loose. We picked up in the grass and mud 6 of our 8 largest fish, and about 200 of the smallest. We lost at least 500 that would have weighed a pound each at the time, and the same number that would have weighed half a pound each. The old ones at present weigh about 10 pounds each. The fish from the last spawning now weigh about 1 pound each.

DIFFICULTIES.—The only difficulty we have met with was the breakage of the pond alluded to above.

93. *Statement of W. C. Hewell, M. D., Cusseta, Chattahoochee Co., Ga., Mar.* 22, 1883.

GROWTH.—The carp received just before Christmas are doing well, and they are three times as large as when I put them in the pond.

94. *Statement of William T. Winn, Marietta, Cobb Co., Ga., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received 26 in November, 1879, and 16 in November, 1880. I have kept them in a lake 110 yards long by 30 yards wide, and from 1 foot to 10 feet deep, with a muddy bottom. A cubic inch of water flows from it. It is fed by springs rising in the bottom. The temperature of the water in summer is 80° Fahr. The water is clear; no surface water flows into it; it never overflows, and can never fill up with mud or sand. It is so permanent that it will stand a thousand years.

PLANTS.—It contains swamp wire-grass and water-lilies.

ENEMIES.—The bass, blue cats, perch, frogs, turtles, and snakes, which formerly infested it have nearly all been expelled by persistent efforts.

GROWTH AND REPRODUCTION.—My carp, of which I have 25 left, now weigh from 7 to 12 pounds, but have produced no young. Walton says, in his Complete Angler, page 151: "There is not a reason found out, I think, by any, why carp should breed in some ponds and not in others of the same nature for soil and all other circumstances." I developed a small pond above mine this spring and put 5 spawners in it, but there was no increase. There were no fish in this pond except the spawners. One pair of spawners placed in a small pond in the Federal cemetery, which dries up in August, were fruitful. I shall put 300 fish annually from the spawning pond into my lake, and think it better than to have them spawn in the latter.

EARLY INTRODUCTION OF CARP.—In 1831, Henry Robinson, of Newburg, Orange County, New York, imported carp from France, which he said in 1851 did pretty well in his ponds.

95. *Statement of Rev. Isaac N. Moon, Powder Springs, Cobb Co., Ga., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received 8 in December, 1880, and 20 in December, 1881. I have kept them in a pond 40 feet wide, 80 feet long, and 4 feet deep, with a bottom of black mud. It is supplied by a weak spring. In spring and summer the water is warm with a scum on top.

PLANTS AND ENEMIES.—It contains willow-grass, water-lilies, &c., &c.; also a few small perch. I keep the frogs and turtles killed out.

FOOD.—I feed the carp on cabbage leaves, lettuce, and bread, about twice a week.

GROWTH AND REPRODUCTION.—I saw two about a year ago. I suppose they are about 20 inches in length and would weigh about 3 or 3½ pounds. I have seen no young yet, and do not know whether there are any or not.

DIFFICULTIES.—I am of the opinion that my pond is too small and shallow. I am building another and would like to get some of the leather carp.

96. *Statement of M. W. Stinson, Everett's Station, Crawford Co., Ga , Oct.* 12, 1882.

GROWTH.—I have a pond near my house that was stocked with a few carp last winter. They have grown to be fine fellows.

97. *Statement of J. R. Cravens, Wildwood, Dade Co., Ga., Mar.* 30, 1884.

GROWTH.—Carp minnows received in 1881 attained a weight of from 2 to 3 pounds in November, 1882.

REPRODUCTION.—In the fall of 1881 I received 20 small German carp, which spawned last spring. I now have from 7,000 to 8,000 yearlings which are doing well.

MISCELLANEOUS.—I am now making a pond, below my carp pond, which I wish to stock with California trout. I expect to feed the trout on the surplus carp minnows escaping from the carp pond above.

98. *Statement of William E. Smith, Albany, Dougherty Co., Ga., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp some time in the fall of 1879 and distributed them among planters in Dougherty and Baker Counties. Some of the ponds in which they were put are supplied by rains and from surrounding hills; but few are supplied with running water. They have muddy or sandy bottoms.

PLANTS.—The principal plants growing in these ponds are "bonnets," water-lilies, and maiden cane.

ENEMIES.—Although the fresh-water ponds of this section are otherwise singularly adapted to carp, the game fish—trout and perch—with which our waters are filled, destroy them. The ponds are invaded by trout, suckers, bream, several kinds of perch, spring frogs, and turtles.

GROWTH AND REPRODUCTION.—There are about 60 of the original lot left. One, when about 11 months old, weighed nearly 4 pounds and was 20 inches long. I am unable to tell how many young they have produced.

99. *Statement of W. H. Carpenter, Concordia, Elbert Co., Ga., Mar.* 27, 1880.

CARP IN SAVANNAH RIVER.—There have been several carp caught in Savannah River that weighed from 6 to 8 pounds. None that have been taken from the ponds will weigh more than from 4 to 5 pounds. The ponds have all been stocked within the last 2 years. Those that are in the river made their escape during high water and the bursting of the ponds.

100. *Statement of R. E. Guthrie, Cumming, Forsyth Co., Ga., July* 15, 1883.

DISPOSITION OF CARP RECEIVED.—I bought 100 from Varner, of Buford, Ga., one year ago this week. I have kept them in a small pond, say ¼ acre in extent, about 5 feet deep, with a muddy bottom. The water comes from a good bold spring, and is very cold when it rises, but gets warm enough in the pond.

PLANTS AND ENEMIES.—No plants have yet come up, and there are no other fish. Frogs and turtles are getting numerous.

FOOD.—I feed the fish from once to three times a day with corn bread and wheat bread. They will eat most any vegetable.

GROWTH.—They will weigh now from 1 to 2¼ pounds. There are no young yet.

DIFFICULTIES.—Frogs and turtles.

101. *Statement of William A. Jett, Atlanta, Fulton Co., Ga., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received 12 carp in February, 1880, and have kept them in a pond of about half an acre, 7 feet deep, with a sandy and muddy bottom. A 2½ inch stream of water flows through it, with a mean temperature of about 60° Fahr.

PLANTS.—The ordinary swamp-lily and grasses peculiar to this section of country grow in the pond.

ENEMIES.—It also contains a few perch and the ordinary black frogs and mud-turtles.

FOOD.—I feed the carp 3 times per week with corn-meal.

GROWTH.—The oldest weigh about 6 pounds, and the others from ¼ to 1 pound each. I have none of the original lot left.

REPRODUCTION.—I cannot tell how many young have been produced, but I have 3 sizes.

MISCELLANEOUS.—I regard the carp as the best pond fish I ever saw, and believe they will be profitable.

102. *Statement of J. A. McCool, Atlanta, Fulton Co., Ga., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received 22 carp in 1880, and 37 more since that time. My pond covers ¾ of an acre, varying from 1 foot to 6 feet in depth, and has a muddy bottom. About 3 inches of water flows into it from springs inside its limits.

PLANTS AND ENEMIES.—It contains no plants or grasses whatever. There are quite a number of frogs and some turtles in it. I keep them cleared out as well as I can. There is a long-toed bug which I think is an enemy of the carp.

FOOD.—I feed the carp every day with various things, but mostly with boiled corn.

GROWTH.—I have taken out 6 by hooks, and the heaviest weighed 4 pounds. They have produced no young that I have seen yet.

103. *Statement of E. B. Plunket, Atlanta, Fulton Co., Ga., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 7 small carp in October, 1879, and none since then. I have kept them in an artificial pond, ⅕ of an acre in size, with an average depth of 3 feet and a bottom of muck. It is supplied from a small spring and with branch water. The water is pretty warm.

PLANTS AND ENEMIES.—There is Bermuda grass around the edge of the pond, and there are a few perch, frogs, turtles, snakes, and terrapins in it.

FOOD.—I give the carp no food at all.

GROWTH.—The original ones, of which there are 5 left, are now from 9 to 12 pounds in weight; and the largest of the young—the one-year-old ones—weigh about 1 pound.

REPRODUCTION AND DISPOSITION OF YOUNG.—I do not know how many young have been produced, but a good number. I have sold a few of them.

104. *Statement of B. J. Wilson, Atlanta, Fulton Co., Ga., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—About 3 years ago I received 30 scale carp, and at different periods subsequently other small lots of scale carp. I have kept them in a pond of nearly 2 acres, from 2 to 10 feet in depth. The bottom is composed partly of pipe-clay, and grassless, but the larger part is covered with decomposed vegetable mud, 4 feet deep in places. About 40 gallons of water per minute enter the pond. The spring which supplies it registers 60° Fahr., but 10 yards away, in 3 feet of water, the temperature is 72°.

PLANTS.—Three or 4 kinds of nameless algæ grow luxuriantly in the muddy bottom; also the common white water-lily. When I formed the pond I planted around the margin the Hicks ever-bearing mulberry, and find it a most excellent fish-food for nearly 3 months in the year. The carp are very fond of the mulberries and become very fat on them.

ENEMIES.—The pond contains bream, sun-perch, and a large-mouthed perch, none of which attain a large size; also some turtles. I have seen no signs of young, and I think the reason is the immense swarm of bull-frog tadpoles that infest the water during winter and spring. They evidently destroy the spawn, and until I find some remedy I fear I will be unable to raise any. I now think of running off the pond lots in the fall after the frogs have ceased to spawn, and destroy the tadpoles.

FOOD.—I feed the carp very little; I give them a few scraps left from the table two or three times a week. [See mulberries under PLANTS.]

GROWTH.—I can't tell how many I have left, possibly 5 or 6. I have caught some weighing 8 pounds.

HOW TO CATCH CARP.—The mulberries are the most tempting bait I know of to use in fishing for them.

105. *Statement of E. M. Lasseter, East Point, Fulton Co., Ga., Sept.* 5, 1882.

GROWTH.—I received 20 fish November last. Two of them were caught for examination on the 2d instant, and were found to be from 10 to 12 inches in length, and would have weighed from 2 to 2½ pounds. When received their length was from 3 to 4 inches, and I think 1 ounce would have equaled the weight of the largest. I am wonderfully pleased with my success.

106. *Statement of Dr. Samuel Hape, Hapeville and Atlanta, Fulton Co., Ga., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 scale carp in November, 1880, and have kept them in a pond, ½ of an acre in size, with a depth of from 12 inches to 6 feet. The flow of water is small, and the temperature varies from 4° to 84° Fahr.

PLANTS AND ENEMIES.—The pond contains few plants besides rushes, flags, and cat-tails. There are lots of frogs and minnows in it. Fish-hawks and cranes are troublesome.

FOOD.—I feed the fish twice a day on stale bread; mostly with crackers that are rancid.

GROWTH.—The heaviest of them would weigh at least 10 pounds. The one-year-old carp would weigh 1 pound; the later ones are quite small.

REPRODUCTION.—I cannot tell how many young they have produced, as the main pond containing them washed away during the storm in May. The first crop is a year old, and there has been another since.

DISPOSITION OF YOUNG.—I have sold a few, but most of them were lost.

DIFFICULTIES.—I have had no trouble with the carp at all. They want regular feeding and protection from fish-hawks and cranes.

MISCELLANEOUS.—They are evidently a great acquisition to our State, and will be successfully cultivated as a table fish and a source of profit where care is taken in their culture.

107. *Statement of T. S. Davis, Toccoa, Habersham Co., Ga., Oct.* 14, 1882.

GROWTH.—The fish I received in last May have grown to be from 12 to 15 inches in length. Only 4 of them have survived.

108. *Statement of W. E. Warren, Powersville, Houston Co., Ga., June* 14, 1882.

GROWTH.—The 8 carp received 18 months ago I placed in a pond covering 2 acres, which was stocked with various kinds of fish. I have seen but one of the carp since, which is from 23 to 24 inches long.

MISCELLANEOUS.—I have constructed a new pond 25 by 80 feet, having a depth of 4½ feet, and desire more carp for it.

109. *Statement of E. C. David, Harmony Grove, Jackson Co., Ga., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 10 carp in November, 1879. I have kept them in a mill pond, covering some 8 acres and from 6 inches to 10 feet deep, with a muddy bottom. The pond is fed from a small creek, and the water is of medium temperature (for this climate) where it enters.

PLANTS.—It contains rushes, water-grass and other grasses, moss, &c.; names unknown.

ENEMIES.—It is inhabited by perch, horny-heads, eels, turtles, and frogs.

GROWTH.—I only know 2 of the carp to be alive. There may be more, as the pond is large and the mud deep in places. It is difficult to take them. The 2 that I have will weigh 15 pounds each. In June of last year I weighed 3 from my pond, one weighing 11 pounds and the other two 15 pounds each.

REPRODUCTION.—There are no genuine young carp. They crossed with the horny-heads.

DIFFICULTIES.—My most serious difficulty has been the crossing of the carp with other fish. I have built a hatching-pond, in which I will allow no other fish but just such carp as I want to raise from. I would be pleased to obtain an extra supply of the scale and mirror carp.

110. *Statement of Jesse White, Harmony Grove, Jackson Co., Ga., Aug.* 9, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp in September, 1880. My pond broke away in June, 1881, and all were lost, but I am going to rebuild it right away, and would like to have another supply.

111. *Statement of J. G. Justice, Marcus, Jackson Co., Ga., Oct.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—I received 8 carp in November, 1880. A freshet broke my dam and they escaped in April, 1880. I received 10 more in November, 1882. I put them in a small pond 6 feet deep, 100 feet in diameter, and with muddy bottom. It is located below a medium-sized spring, from which there comes very cold water. I am sure the water is too cold in summer for the best results, and am building a larger one farther away, so as to have warm water.

PLANTS.—It contains a vine-like plant.

ENEMIES.—It contains none, except frogs.

FOOD.—I give them corn bread once or twice a week.

GROWTH.—They are now 8 to 10 inches in length.

112. *Statement of Henry P. Farrow, Porter Springs, Lumpkin Co., Ga., Feb.* 2, 1884.

PONDS AND WATER.—My largest carp pond is over 1 acre in area, and its greatest depth would exceed 10 feet, while a due proportion is quite shallow. This pond in the heat of summer warms up to 85° F. Near by is my pond for red speckled brook trout, which is equal to 75 feet square, and of almost uniform depth of 5 feet, with springs all over the bottom of it, and spring branches coming to it, and it never freezes over in winter, and never gets above 64° F. in summer.

GROWTH AND REPRODUCTION.—The carp are doing well, and have evidently grown during the winter. To-day they are as active as in midsummer. They fed all through October and in November. December and January are the only months during which they hibernate here, if they can be said to hibernate at all. The hatching of carp last summer must have been very heavy, as the display of young ones is very fine.

113. *Statement of G. H. Slappey, Marshallsville, Macon Co., Ga., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp from several quarters, about 80 altogether, in January, 1880. I had 5 ponds of cold water. The upper one, in which I kept the carp, was a spring, surrounded by a bluff. There was no branch running into it, and the water was cold.

PLANTS.—It contained many sorts of grass, water-grass, lilies, and bonnets.

ENEMIES.—There were no other fish in it. I think that carp will do well enough with other fish, especially suckers or red-horse.

FOOD.—I fed them on meal and mutton or soft corn.

GROWTH.—They were from 6 to 12 or more inches long when I lost them in 1882.

STREAMS STOCKED.—I think the carp will do well in this country. The Ocmulgee and Flint Rivers seem to be well stocked, on account of the breaking of fish ponds. Many have been caught in them with nets. I think all our rivers will soon be full. Our lakes also have carp.

EDIBLE QUALITIES.—The numerous carp caught in the rivers are said to be very fine eating.

DIFFICULTIES.—Sorrow and misfortune befell me in September, 1882. A flood—a nonesuch—which washed away and broke every mill and railroad in this county, carried all the carp into the river. Very few fish ponds in this county escaped. My carp must have passed through four ponds, and some of my neighbors think some of them must be left in the mud. I have hunted much for them and cannot find any, but I am in hopes some are left. I would like to have some more sent me.

114. *Statement of M. S. McCarithery, Danielsville, Madison Co., Ga., April* 6, 1883.

GROWTH AND REPRODUCTION.—My carp, received in 1881, are doing well, some of them being 16 inches long. There are plenty of young carp in my pond.

115. *Statement of Harrison Summerour, Warsaw, Milton Co., Ga., Aug.* 4, 1883.

Disposition of carp received.—I received 6 carp in November, 1879, and a few in 1880. The size of my breeding pond is about ½ of an acre. It is from 1 foot to 8 feet deep, and has a muddy bottom. About one gallon of water per minute flows through it, with a temperature of from 60° to 65° Fahr.

Plants and enemies.—The breeding pond contains native grass, such as the rush; also a lot of frogs and fine turtles, but no other fish.

Food.—I give the carp scraps from the table, boiled potatoes, and any other food that is eaten by the family.

Growth.—I have 14 of the original fish left. The oldest weigh from 8 to 10 pounds, and the next size about 6 pounds. The young ones weigh from 4 ounces to 2 pounds.

Reproduction and sales.—I have transferred about 3,000 young ones out of the breeding pond, and it is full yet. I have disposed of about 200.

Miscellaneous.—I have 8 ponds altogether, and have stocked them all with carp. I am delighted with them. I wish to try the leather variety, as I have none but the scale.

116. *Statement of Abner T. Holt, Bolingbroke, Monroe Co., Ga., July* 27, 1883.

Disposition of carp received.—I received 72 carp in January, 1880, and have kept them in a pond 150 feet long, 12 feet wide, and from 2 to 10 feet deep, with a bottom of pipe clay. About 6 gallons of water per minute flows through it. In the middle of the day, July 20, the thermometer registered 88°.

Plants and enemies.—It contains rushes; also bream, red-horse, trout, minnows, perch, and silver roach, turtles and frogs.

Food.—I give them maggots, principally from dead carcasses, and some bread, as often as required.

Growth.—The last one I measured, about one year ago, was about 11 inches long. They are doing well; no difficulty.

117. *Statement of Emanuel Heyser, Madison, Morgan Co., Ga., July* 23, 1883.

Disposition of carp received.—In November, 1879, I received 16 mirror carp and 13 scale carp, and in December, 1881, about 50 mirror carp. I have kept them in different ponds, usually containing about ¼ of an acre, 5 feet deep, and having a muddy bottom. The water is supplied by springs in sufficient quantity to make a flow through a pipe 3 inches in diameter. It stands at about 80° now.

Plants.—The ponds contain pond lilies, native grass, and water plants.

Enemies.—They also contain native fish, such as bream, perch, and catfish, some frogs, a few turtles, and moccasin snakes. The annoyance arising from these, of which I am trying to rid my pond, is the only difficulty which I have experienced.

Food.—I feed wheat, unbolted, mixed with corn-meal and baked, once a day.

Growth.—I now have 11 of the mirror carp and 5 of the scale carp left from the 1879 lot. The old ones are now from 5 to 8 pounds each. Those hatched in 1882 now average about ½ a pound each. Those hatched in 1883 are about 3 inches long each. I cannot say how many there are.

Reproduction.—They first spawned early in May, 1882. There were very few mirror carp. I took 4,000 scale carp from the pond, and think I left as many. Some of the carp spawned the first week in May, 1883. The others have not spawned yet.

Disposition of young.—I have sold about 1,000 young carp to stock other ponds, and have stocked my own ponds with the balance.

118. *Statement of Josiah Perry, Covington, Newton Co., Ga., July* 23, 1883.

Disposition of carp received.—I received 16 carp in October, 1880, and 20 this spring. The pond which I have kept them in is 1¼ acres large and about 7 feet deep. The bottom is about half muck, and the water is warm.

Plants.—It contains grass and water plants that are indigenous to this climate.

Enemies.—It has in it a few turtles, frogs, and branch fish, such as are found in all branches in this section. My principal difficulty has been the destruction of the eggs of the carp by the frogs and perch.

Food.—I feed the carp once every day with corn-bread.

Growth and reproduction.—I have 11 of the original lot left. The old ones were from 5 to 10 pounds in weight last October. The young now weigh from 1 to 2 pounds. I do not know how many young there are.

119. *Statement of J. R. Ellis, Griffin, Spalding Co., Ga., April 3, 1883.*

GROWTH.—A carp that was placed in Mills's pond 2 years ago, and escaped when the pond broke, was caught yesterday in Pitts's pond, 4 miles below this place, and found to weigh 15 pounds. A scale from the fish measures 1¼ by 1 inch, and is in the possession of Captain Hartnett.

120. *Statement of Abel A. Wright, Griffin, Spalding Co., Ga., July 23, 1883.*

DISPOSITION OF CARP RECEIVED.—In 1879 I received 14 carp alive out of 200 that had been sent me from California. I have since received 22 through the State commissioner and 23 direct from Washington. My pond covers about 1 acre, is 8 feet in deepest part, with a bottom of black mud and alluvial deposit. The water is brought from a spring 1,000 feet distant in a pipe 4¾ inches square. In addition there is a bold spring in the pond. The water is 70° on the surface; 80° in midsummer.

PLANTS.—The pond contains *Victoria regia*, *Nymphæa odorata*, *Nymphæa flava*, *Nymphæa alba*, *Nymphæa* (or Nuphar) *advena*, *Nelumbium luteum*, *Nelumbium speciosum*, several kinds of *Pontederia*, various ferns, mosses, rush, marsh grass, Bermuda grass and other grasses, waumpee, water oats, and *Calamus acorus*. In the spawning season all kinds of aquatic plants, Bermuda grass, all kinds of rush, water grasses, regular marsh grasses, and all ferns and mosses are useful. Weeping-willow roots also are fine for them to deposit their eggs on. Cat-tails are a nuisance.

ENEMIES.—I kill all the frogs, terrapins, turtles, and water-snakes. The frogs eat carp, toads, and small frogs of their kind. I have killed frogs containing carp 6 inches long, and water-snakes containing carp 8 to 10 inches long. The most serious difficulty encountered is to keep these injurious animals, as well as the kingfishers, bitterns, cranes, herons, and fish-hawks, killed off, to prevent their destroying the young.

FOOD.—I feed the carp with wheat, pumpkins, and squashes, uncooked; boiled corn, sweet potatoes, bread of all kinds, stale baker's bread, damaged crackers, lettuce, cabbage, and table refuse. They also feed on the seeds and tender roots and shoots of the aquatic plants.

GROWTH.—I have caught carp weighing 10¼ pounds, and have had large ones break No. 4 hooks and eight-day-clock cord. I have seen those that looked to be 30 inches or more long and a foot wide. This season's hatching are from ⅝ of an inch to 5 inches long.

REPRODUCTION.—They have produced young by millions. It is impossible to tell how many. They have done better this year than ever before. The old ones are still spawning, while last year they spawned till frost chilled the water. I am satisfied carp spawn at 12 months old, and not at 24 months, as in Europe. Our waters are warmer. I know a gentleman in Atlanta that had one-year-old carp and gold fish together, and they mated and hatched young at that age. I have seen one-year-old carp in my pond spawning, have removed the eggs, and hatched them in a bottle of water set in the sun in March.

SHIPMENT OF YOUNG CARP.—I have sent young carp to Pennsylvania, Virginia, North Carolina, South Carolina, Kentucky, Tennessee, Louisiana, Texas, Arkansas, Florida, and all over Georgia.

HOW TO CATCH CARP.—I catch carp with hook and line. They bite greedily at grub worms, flatheads, mush or dough, and cotton.

121. *Statement of Solicitor-General C. B. Hudson, Americus, Sumter Co., Ga.*

GROWTH.—I let the water out of my pond a few days ago and caught a carp 18 months old, which made a meal for three families. All of the carp averaged from 10 to 15 pounds each.

122. *Statement of A. D. Bates, Thomasville, Thomas Co., Ga., Nov. 2, 1881.*

DISPOSITION OF CARP RECEIVED.—The 12 carp, measuring from 2 to 3 inches, received two years ago, I put in a small, muddy pond, about 40 by 60 yards, and 6 feet deep.

PLANTS.—The pond is surrounded by weeds and shrubbery.

ENEMIES.—No other fish than carp live in the pond.

GROWTH.—As I did not know whether the carp were alive or not, I drew off the water from the pond this afternoon. I realized results which exceeded even my most sanguine expectations, having found 8 of the original carp which were 25 inches long and weighed 7½ pounds each.

REPRODUCTION.—It seems that the original carp spawned in the springs of 1880 and 1881, as the young are of two sizes, and 6 and 18 months old. I obtained 100 young, averaging 1 pound in weight.

MISCELLANEOUS.—I never saw a finer lot of fish, and believe the culture of the carp will surpass hog-raising. Many of the citizens who witnessed the drawing of the pond resolved to obtain the seed of the wonderful fish and raise their meat without trouble and in abundance.

123. *Statement of J. T. Chastain, Thomasville, Thomas Co., Ga., July* 17, 1883.

DISPOSITION OF CARP RECEIVED.—In 1880, I think it was, I received 16 young carp. They were consigned to C. P. Hansell, but were for me. The following year I received 12, similarly consigned. My pond was then filled with all sorts of fish. In consequence, the young carp were placed in a small pool fed by a spring. In the fall of 1881 nearly all the ponds in this section went dry, my pond and the little pool included. Before the young carp could be taken from the pool, fish-hawks and similar birds caught a good portion of them. I took out 5 of the older ones and about the same number of the latter shipment. They were turned loose in a twenty-acre pond.

In the spring of 1883 I received 11 more. These were placed in a pond covering four or five acres, 5 feet deep in the center, growing gradually shallower to the edges. The bottom of this pond is sandy near the edges, muddy in the center. It has a spring head of still water which flows only at times. The temperature is from 70° to 80° in summer. Thin ice occasionally forms around the edges in winter.

PLANTS.—The small pond abounds in water-moss, with some marsh or water grass.

ENEMIES.—There are no other fish, but there are spring and bull frogs and water terrapins. [Fish-hawks—see above.]

FOOD.—No food was regularly given to the 2 former lots which were kept in the pool. I occasionally feed the fish I have now in the small pond on bread, but have never seen them since they were turned loose in the pond.

GROWTH.—When the ponds were dried up, in 1881, the one-year-old fish which I saved weighed about a pound apiece, and the younger ones about a quarter of a pound. One was taken a few months later with a hook, but replaced. It showed rapid growth. This spring one escaped during a freshet—one of the younger ones. We estimated that it would weigh at least 10 pounds. A week or two later one of the older ones, about 2½ years of age, was caught in the mill-wheel and killed, but as it was cut in several pieces, its weight could not be definitely ascertained. It was, however, considerably larger than the former one taken, and perhaps weighed 14 pounds.

124. *Statement of H. H. Cary, M. D., La Grange, Troup Co., Ga., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 11 carp in November, 1879, which I placed in a private pond ¼ of an acre in extent, with a muddy bottom. The inflow is 60 gallons per minute, and the temperature of the water in midsummer is above 90°.

PLANTS.—Bermuda grass and other wild grasses and water-lilies grow in the pond.

ENEMIES.—I try to keep all other fish out. Some frogs and turtles will get in. I have had great difficulty in keeping out the tadpoles. I am satisfied they destroy the eggs.

FOOD.—I give the carp refuse from the kitchen, corn, wheat, oats, and almost anything that pigs will eat.

GROWTH.—I have 7 of the original lot left; they average 10 pounds apiece. The young ones weigh from ½ an ounce to 4 or 5 pounds.

A large pond was broken, in April last, in an adjoining county by a freshet. The carp were captured by the use of a seine. The small fry, weighing only a fraction of an ounce when put in, had been in it only 16 months. The aggregate weight of 3 of the fish when captured was 25 pounds—the largest growth for the time I ever knew of. I get this from reliable parties.

REPRODUCTION.—Several thousand young have been produced.

PERIOD OF INCUBATION OF EGGS.—I have been taking some pains for the past 2 years to ascertain the period of incubation of the eggs. A statement in the Fish Commissioner's report for 1875–'76 that they hatch in from 12 to 16 days was doubtless based on a lower temperature of water than prevails in this latitude during the hatching season. Last year, with the temperature of the water at about 69°, the eggs hatched in 5 to 6 days. The present year, with a higher temperature of water, a more carefully conducted experiment has demonstrated that the eggs hatch in from 48 to 72 hours. The eggs hatch finally in water at a temperature of 90°.

DISPOSITION OF YOUNG CARP.—I have stocked several ponds with young fish from mine.

MISCELLANEOUS.—Over 3,000 ponds in the state of Georgia have been stocked with carp, and this fish continues to more than maintain its high character as a valuable pond-fish.

125. *Statement of W. L. Benham, West Point, Troup Co., Ga., May* 2, 1883.

ENEMIES.—I find that the most destructive enemy of the carp is the cray or craw-fish, found in low marshy lands. Last November I placed in a pond to themselves about 100 carp. One month ago I drew the water and found about 50 left, many of which had their tails and fins eaten off. There were numerous crawfish in the pond, which have undermined the dam and allowed the water to escape. I am somewhat discouraged in fish-culture.

126. *Statement of George W. H. Sisum, Gaddistown, Union Co., Ga., Feb.* 1, 1884.

GROWTH.—I have 32 carp that will be 3 years old this spring, and 25 yearlings which measure from 12 to 14 inches in length, and which I expect will spawn next summer.

127. *Statement of H. L. Spencer, Social Circle, Walton Co., Ga., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received 6 carp about 4 years ago, and have received a few since then. I have kept them in different ponds—mill-ponds and fish-ponds—having various depths and kinds of bottom. Fair streams flow through the mill-ponds; but the water supply is very small in my fish-ponds.

PLANTS.—The ponds contain water-lilies, swamp flags, and some other growths not known to me.

ENEMIES.—They have rather a general assortment of fish, frogs, turtles, &c. They had been stocked with other varieties before I got carp.

FOOD.—I have not been able to feed the carp regularly with any particular kind of food.

GROWTH AND REPRODUCTION.—About 3½ pounds is the largest we have ever seen; there may be larger ones. Few, if any, of the original 6 are left. I fear that they have been caught and stolen. I am unable to tell how many young they have produced.

DIFFICULTIES.—Some of the carp caught in our fish-ponds this spring had sores on them, and something like hair or long mossy stuff adhering to their backs.

Since receiving carp we have been very busily engaged in other matters which have prevented us from looking after our fish interest; but we hope in the future to give the matter considerable attention, as we are, we think, in much the best shape of any one in this part of Georgia to do a good business in this line, and hope we may make it a success.

IDAHO.

128. *Statement of A. B. Roberts, Boise City, Idaho, Nov.* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received yesterday, through the Pacific Express, one pail containing 18 carp. I took them out to my pond to-day and put them in, but not in the open pond. I constructed a box about 18 inches by 2 feet, and 6 inches deep, on this I nailed a frame of sufficient height to reach above the top or surface of the water, and around this frame a wire-cloth screen. I then filled the box with loam, which sunk the box to which the screen was attached.

FOOD.—I then put in the carp and fed them a little rye chop, about a tablespoonful, and about one-half as much crumbs of bread. I intend to give them a piece of boiled potato in a day or so, which I will slightly mash before putting in.

HABITS.—When the little fellows were put into the screen-tank they went to the bottom and took a survey of the condition of things there; then, in a few minutes, some of them were seen dodging around, and occasionally one would strike the surface as if catching some small insect that lay on the water.

ILLINOIS.

129. *Statement of W. W. Robertson, Beverly, Adams Co., Ill., Sept.* 29, 1882.

GROWTH.—The carp put in my pond 1 year ago are doing finely and are growing fast, and seem to be adapted to our waters.

130. *Statement of J. H. Black, Clayton, Adams Co., Ill., Sept.* 10, 1882.

GROWTH.—The carp, not exceeding 3 inches in length when received last December, are now from 12 to 14 inches long. They can be seen on any clear day.

131. *Statement of Quincy Burgesser, Clayton, Adams Co., Ill., Aug.* 11, 1884.

GROWTH.—The 10 carp, about 2½ inches long when received December 15, 1882, were on September 20, 1883, from 14 to 16 inches long.

EDIBLE QUALITIES.—The other day Mr. H. R. Matter and myself repaired to his pond with hook and line, determined to test the eating qualities of carp. After about a half hour's wait for a bite I succeeded in landing a very fine carp weighing 4½ pounds and about 20 inches in length. It was as beautiful a fish as you would wish to look at, it being one of the lot received in November, 1882. We had the fish prepared in good style and invited a few guests to pass judgment on its merits. Suffice it to say that the fish was pronounced by every one to be of as fine a flavor as any fish, far surpassing the buffalo, or even the much-sought-for catfish; and to my taste it was more palatable than even the salmon or halibut of the East. I am perfectly satisfied if this one was a fair specimen of the carp. I do not ask any better fish for my use, and this was the decision of all who partook of it.

132. *Statement of S. P. Bartlett, Quincy, Adams Co., Ill., Sept.* 18, 1883.

CARP IN THE RIVERS.—There have been a number of carp taken from the Mississippi with hook and line and by seine, several above Quincy, and a few days ago one near Hannibal in the Sue River. The latter weighed a little over 8½ pounds and was of the mirror variety. Mr. Abner Foster, of Beardstown, Ill., on the Illinois River, writes me as follows: "Have you at any time planted carp in the Illinois River? My reasons for asking is that one was taken from the river near here weighing about 8 pounds. I procured it alive and put it in my pond." As we value carp too highly to experiment with by putting them into the river, those taken must have escaped from live boxes or from ponds. It nevertheless demonstrates the practicability of eventually stocking our streams with this wonderful fish.

Three years ago Illinois secured some of the first carp distributed by the United States Fish Commission. Since that time there have been built, or arranged for their accommodation, nearly 2,000 ponds, a large number of them being stocked, and some already have produced their first increase; and if the large number of letters received by the Commissioners is to be regarded as evidence, very few of those applying for and receiving the fish have had any complaint to make. The almost universal testimony is that the fish have grown beyond the most sanguine expectations, and it seems to have mattered little whether they have been planted in northern or southern counties; they have as readily adapted themselves to the waters and at once made themselves at home.

A gentleman residing in Henry County writes:

"I received from the United States Fish Commission, in December, 1881, some German carp. I placed them in a large pond, used principally for making ice. During the rainy months the dam gave way, and I supposed my fish were all gone, but upon draining off the water left in small holes I found 3 of them, measuring from 16 to 18 inches long, weighing from 2½ to 4 pounds each."

Another letter from Adams County, under date of September 15, 1882, says:

"The carp you sent me in December, 1881, when received were but from 2 to 2½ inches in length. Now they measure from 14 to 16 inches. They come to the surface whenever I go to feed them, and, in fact, I sometimes think they know my step. They eat almost anything of a vegetable nature. I would not part with my fish for any reasonable amount."

And still another, from Jackson County, dated October 15, 1882, says:

"The fish received from the State fish commission were placed in the pond, in good shape, December 15, 1881. I had not seen them, as I wrote you, up to September 1, not having fed them daily, but having, as you suggested, placed a sack containing shipstuff in pond, supposed they had sufficient food. Judge my surprise, upon making an examination of my pond by drawing a seine, to find that the carp were from 20 to 21 inches in length, beauties indeed, and to find all the old carp there and my pond full of what I suppose are young carp. As my pond was clear of other fish they must be such. Put me down as being no longer skeptical as regards big fish stories."

The fish noted in the above extracts are all now but little over a year old, none of them having been planted before December, 1881, and when it is taken into consideration that the fish, as a rule, do not grow during the winter months, it follows that this remarkable increase in size must have taken place in less than 9 months, showing an average growth of from 14½ to 15 inches in that length of time, even in the northern part of the State.

133. *Statement of the editor of the Quincy Whig, Quincy, Adams Co., Ill., Sept.* 19, 1884.

DISPOSITION OF CARP RECEIVED.—About 2 years ago 60 young carp were planted in the large pond at Highland Park, when none of them were over 5 inches long. This pond was dry a short time before the carp were deposited therein. It is only such a pond as any farmer can have.

GROWTH.—The pond was seined yesterday, and among the fish taken was a magnificent specimen of carp about 2 years old, and which measured 17 inches in length and weighed 9 pounds and 3 ounces. The others were returned to the water.

EDIBLE QUALITIES.—The officers of the Highland Park Association gave their first annual fish dinner yesterday, and after the chowder and fried fish had been discussed the carp was brought on. It was elegantly served, and every person who had the good fortune to be present pronounced it superior to any of the native fish prepared for the occasion. When taken from the water the gills were of a deep red color, differing materially from the color of any of our native fish, and the meat was of a rich gold shade, very hard and firm, being quite similar to the salmon.

134. *Statement of C. G. Cushing, Princeton, Bureau Co., Ill., Oct.* 6, 1882.

GROWTH.—The carp, which were placed in a pond from 5 to 6 feet deep and supplied by spring water, have grown to be from 10 to 12 inches long, and weigh about 1½ pounds each.

135. *Statement of W. G. Delashmutt, Martinsville, Clark Co., Ill., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received 8 fish alive in May, 1881, and placed them in a pond covering 5 acres, with a muddy bottom; water from 2 to 15 feet deep.

ENEMIES.—The pond also contains catfish and sun-fish, but no plants. I have not fed the fish.

DIFFICULTIES.—The size of the pond and its depth has thus far prevented us from knowing how the fish are doing. The bottom of the pond being filled with stumps, we cannot use a seine.

136. *Statement of John Dean Caton, Chicago, Cook Co., Ill., Sept.* 17, 1884.

DISPOSITION OF CARP.—I placed the carp received 2 years ago in a pond 10 miles northwest of Joliet, Will Co., Ill. The pond is 300 feet in diameter, excavated to a depth of from 5 to 6 feet, in stony blue clay. It is supplied with water from an artesian well, from a depth of 148 feet, at a temperature of 67°. The supply of water must average from 80 to 90 gallons per minute, and is plainly impregnated with sulphur and iron, but is good for domestic use.

PLANTS.—There is no shade in the pond as yet.

FOOD.—The carp are fed with vegetable food, but I fear not always abundantly.

GROWTH.—But 2 of the carp have been taken, and they were found to weigh about 4 pounds.

REPRODUCTION.—The young fish seem to be abundant. They more frequently appear on the surface just after sunset, but disappear at the least alarm. They seem to work continually in the clay banks and bottom, so that the water is kept constantly discolored.

EDIBLE QUALITIES.—The 2 fish taken were found to be good on the table.

HOW TO CATCH CARP.—Carp are very shy and difficult to capture. One was taken on a hook and the other in a net. Quite a number were inclosed in the net, but all but the one jumped over the net and escaped. They seem to be very active.

137. *Statement of H. Hammerschmitt, Naperville, Du Page Co., Ill., Aug.* 7, 1882.

DISPOSITION OF CARP RECEIVED.—In the fall of 1880 I received 16 small scale carp and placed them in my pond the following spring. I also obtained a lot of mirror carp in the fall of 1881.

FOOD.—The carp come for their food every evening like chickens.

GROWTH.—This summer I found the mirror carp to be from 10 to 12 inches long and the scale fully 18 inches.

REPRODUCTION.—They also seem to have spawned, as a number of small ones have lately made their appearance.

DIFFICULTIES.—Prior to the receipt of the mirror carp 8 of the scale carp were found dead and all the rest kept out of sight.

138. *Statement of W. Thompson, Effingham, Effingham Co., Ill., Sept.* 25, 1882.

GROWTH.—I saw a number of my carp yesterday, and they seemed fat and plump and in excellent condition. When I received them last fall they were from 3 to 4 inches long; now they measure from 12 to 14 inches in length and weigh from 1½ to 2 pounds.

139. *Statement of Charles W. Davenport, Cambridge, Henry Co., Ill., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp in 1880, and several subsequent shipments. I have 4 ponds, covering over 4 acres of water, the banks well lined with willows and other shade trees. The temperature of the water is from 70° to 80°. The pond in which I put the carp covers about three-fourths of an acre, from 1 foot to 6 feet deep, and contains no other fish, frogs, nor turtles.

FOOD.—I fed the carp on coarse baked meal, crackers, and liver.

GROWTH.—In draining my pond last fall I found 35, mostly leather carp, measuring from 16 to 21 inches in length. The heaviest weighed 4 pounds and 10 ounces. They attracted much attention and were regarded as a marvel of growth and beauty. They were of the shipment received in November, 1881, and November, 1882.

DIFFICULTIES.—I have had no difficulties except with floods and high water. These have been disastrous. I have lost all my fish thereby, but am not discouraged. Two of my ponds are stocked with native fish, but they develop very slowly and are destructive to one another. I am preparing to drain them, and shall use all my ponds for carp—the large ones for adult carp and the small ones as nurseries.

140. *Statement of Van Wilbanks, Mount Vernon, Jefferson Co., Ill., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—I received 7 carp in June, 1880, and 10 in June, 1882. The bottom of my pond is a mixture of mud and sand. The water is of moderate temperature in summer, with about 6 inches of ice in winter. There are no plants except a few willows around the edges.

ENEMIES.—There are no enemies except an immense number of craw-fish.

FOOD.—We feed graham bread and meal.

GROWTH.—The old carp are about 2 feet long and weigh about 4 pounds each. There are 4 of these left. The second lot have attained the length of 12 inches in one year. They have not spawned yet. They have been no trouble to us.

DIFFICULTIES.—I find by seining the pond that there are no young. I know of no cause except the possibility of the immense number of crawfish having devoured the spawn.

141. *Statement of J. P. Dimmit, Decatur, Macon Co., Ill., June* 1, 1882.

GROWTH AND DIFFICULTIES.—Mr. L. L. Haworth had his pond overflowed by the Sangamon River and lost all except 2 of his carp, which, however, are 14 inches long and weigh 2 pounds each.

142. *Statement of D. T. Kyner, Macon, Macon Co., Ill., Aug.* 24, 1883.

GROWTH AND REPRODUCTION.—The 20 carp received last fall have grown finely and now average about 10 inches in length. I have an immense number of young, which are all covered with scales, while on the large carp there can be found very few.

143. *Statement of Samuel R. Thomas, Virden, Macoupin Co., Ill., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received some carp in November, 1881, and put them in a small pond until May, 1883, when I transferred them to a large pond with a muddy bottom. The water is surface water from grass land.

PLANTS.—The pond contains a good many water plants. River moss is very thick in it.

ENEMIES.—The large pond has some croppy and bass. In the smaller one I keep only the carp and buffalo.

FOOD.—I feed them with wheat and stale bread.

GROWTH.—Their present length is from 14 to 16 inches, and they weigh about 2½ pounds each. They have not spawned yet. I intend to make small ponds for them to hatch their young in, so as to keep them separate the first year.

144. *Statement of George L. Zink, Litchfield, Montgomery Co., Ill., Aug.* 26, 1882.

GROWTH.—About the second week of last November a can containing 10 pairs of carp was received and placed in a private pond and fed during the winter. Recently I seined the pond to ascertain my success. I succeeded in landing 1 only, and upon measurement it showed a length of 11¾ inches.

145. *Statement of J. C. Hart, Monticello, Piatt Co., Ill., Feb.* 25, 1884.

GROWTH AND REPRODUCTION.—The carp you sent me 2 years ago have grown well. I weighed 2 carp in June, 1882, which weighed 1½ and 1¾ pounds, respectively. One in October, 1882, weighed 2 pounds, and 1 in September, 1883, weighed 4 pounds. There were some young hatched last summer; I do not know how many.

146. *Statement of Madison Miller, Percy, Randolph Co., Ill., Sept.* 25, 1882.

GROWTH.—One of the carp received last spring was caught this month and was found to be 17½ inches long and to weigh 46 ounces.

147. *Statement of J. Keller, Steeleville, Randolph Co., Ill., Aug.* 1, 1882.

GROWTH.—The German carp received last fall have done so remarkably well that I have commenced another pond on a larger scale. The largest are now about 13 to 14 inches long and weigh about 1½ pounds, the most astonishing growth I ever beheld in a fish.

148. *Statement of E. H. Norwood, Olney, Richland Co., Ill., Aug.* 6, 1884.

DISPOSITION OF CARP RECEIVED.—The 20 carp received in the fall of 1882 and the 20 received in November, 1883, I placed in a pond 40 by 200. I have never seen the fish until last night, when I caught 2 with a net, one weighing 4 pounds and measuring 19½ inches in length, and the other being 12 inches long.

149. *Statement of John Meyer, Addieville, Washington Co., Ill., Oct.* 4, 1882.

GROWTH.—I saw 3 or 4 of my carp to-day, and was surprised to find them of such enormous size. About 10 months ago they were no more than 3 inches long, and they now measure 15 inches in length.

150. *Statement of A. H. Baker, Fairfield, Wayne Co., Ill., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—Two years ago I received 20 carp and put them in a pond of half an acre, from 2 to 10 feet deep, of which from 2 to 8 inches is mud. The pond is composed of surface water, with no overflow, except after rains.

PLANTS AND ENEMIES.—The pond contains grasses and various kinds of weeds. There are some small catfish and sun-fish, but no frogs nor turtles.

FOOD.—I have fed them but very little. For a while I gave them cooked corn and meal.

GROWTH.—I still have all but a very few that got out when the pond overflowed, and should estimate that they would weigh 3 pounds each. They have given us but little care and no trouble.

151. *Statement of John Lowe, Johnsonville, Wayne Co., Ill., July* 21, *and Sept.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp November 26, 1880. My pond has a surface of about 100 square rods, with clayey or muddy bottom, and is 6 feet deep in the center. It is fed by the rain falling on about 2 acres. I have found it heated to 108° in summer, and ice 26 inches thick on it in winter.

PLANTS.—Red top and red clover line the edges, and occasionally a large-leaved water-grass.

ENEMIES.—It contains craw-fish, one small water terrapin, a few frogs, but no other fish.

GROWTH.—I have seined my pond and find quite a quantity of last year's carp. They were about 7 inches long and weighed ¼ of a pound each. I took 3 of the old ones. One measured 22½ inches in length and weighed 4¼ pounds. They were beauties, and looked like our common buffalo suckers.

REPRODUCTION.—They spawned June 2 and 8, 1882, but none hatched. I thought it was too cold—42°. Again, on June 11, 1883, they spawned and none hatched; the water was 86°. I took several thousand spawn and tried to hatch them in buckets, but failed. I fear the carp are all females. I think I shall have a great plenty of young by next year, however. I have had a good many calls for stock.

EDIBLE QUALITIES.—We ate some of the young carp fried, and found them most excellent.

INDIANA.

152. *Statement of J. W. Bortsfield, Selma, Delaware Co., Ind., Nov.* 17, 1883.

DISPOSITION OF CARP RECEIVED.—I first received 20 carp January 14, 1881, and subsequently another lot in November, 1882. My pond measures 75 square feet, is 6 feet deep, and has a muddy bottom. When I put the carp in the pond I had to cut the ice.

PLANTS.—Plants that are indigenous here grow in the pond.

ENEMIES.—This summer I found in the pond 1 catfish, measuring 5 inches in length. I found no carp in the pond. The catfish may have eaten them.

153.—*Statement of George T. Ager, Goshen, Elkhart Co., Ind., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—February 22, 1881, I received 15 pairs; April 14, 1881, I received 30 pairs; and March 17, 1882, I received 10 pairs. My lake covers 70½ acres, 65 of which is good water. It has a muck bottom and is covered with water grass. The deepest water is 15 feet, the average 5 feet. The temperature is 50° in spring and 70° in summer.

PLANTS.—The pond contains lilies, water-grass, alder brush, willows, and all such plants as are common to our creeks and lakes.

ENEMIES.—There are no other fish, but there are frogs and turtles. Dipper ducks and snappers have been very troublesome. I gave them no food whatever.

GROWTH.—Nine that I found before April 6, 1883, weighed from 8 to 15 pounds. The largest of these measured 27 inches in length, 9 inches in breadth, and 4 inches in thickness.

REPRODUCTION.—They have produced fully 75,000 young, that reached 2 pounds in weight last autumn. Those that I see daily are now from 10 to 17 inches long and weigh from 3 to 3½ pounds each.

MORTALITY.—Speeding horses and cutting ice on the lake, 1882-'83, killed not less than 60,000. But for this calamity I should have tons of carp on the market this fall. Although I have carp left, I do not know in what quantity. I think the originals were not all lost, as I could find 9 of the largest size. The two-pounders were as numerous as the pounders. Competent judges estimate the number of dead at 66,000, or 10 tons weight, which I think below the real number, as there were many hundreds on the bottom; the estimate having been made for those floating on the surface only. There were others larger, especially the mirror kind, laden with spawn. Such a growth and quantity I believe to be unprecedented in this country for such a time and plant, and the sight has been viewed by hundreds of people.

154.—*Statement of John H. Baker, Goshen, Elkhart Co., Ind., Apr.* 12, 1883.

DISPOSITION OF CARP RECEIVED.—Two years ago last fall the carp were placed in a pond covering about 80 acres, with a maximum depth of about 15 feet.

GROWTH.—The fish were thrifty, and when the winter came on they would average from 1 pound to 2½ pounds.

MORTALITY.—The winter has in some way killed them all. To-day I counted 176 dead carp on the margin of the pond. How they were destroyed I cannot tell.

155. *Statement of Charles H. Brown, Connersville, Fayette Co., Ind., March* 1, 1883.

GROWTH.—The carp received in the fall of 1881 have done splendidly. I think I have some that will weigh nearly 3 pounds. They did not spawn last season.

156. *Statement of John S. Coffman, Galena, Floyd Co., Ind., Aug.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp November 23, 1880. I have them in a pond covering 1 acre. It is fed by small springs, and very little water runs out. It stands at about 70°.

PLANTS AND ENEMIES.—The pond contains natural plants and grasses of the creeks and swamps here. There are no enemies except some green frogs, which we try to kill out.

FOOD.—We feed them with stale bread about every day.

GROWTH AND REPRODUCTION.—We have 8 of the original lot, and they are from 17 to 18 inches long. There may be some young ones, but I cannot tell certainly. There has been no difficulty with them.

157. *Statement of J. B. James, New Albany, Floyd Co., Ind., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in 1879 and 20 in 1881. The first lot was placed in a 5-acre pond, full of all sorts of fish, including bass, &c. The second lot was kept in a box 3 by 4 by 6 feet, and sunk in 5 feet of water. In the spring of 1882 there were 18 found in good condition, but the Ohio River flood soon after carried them all away.

158. *Statement of Samuel B. Ensminger, Danville, Hendricks Co., Ind., Sept.* 6, 1883.

VALUE.—Some of my neighbors have carp which you sent them, which they ask $10 per pair for.

159. *Statement of Dr. Seth G. Bigelow, Silver Lake, Kosciusko Co., Ind., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 18 carp November 23, 1880, and twice subsequently. My pond is dug out of muck, from 1 foot to 5 feet deep, very soft and sticky. The water comes from a spring 3 rods away, and is not very cold.

PLANTS.—The pond contains sweet flags, piper grass, wild grass. It contains no other fish nor turtles—only frogs. There were formerly muskrats, but I cleared them out.

FOOD.—I feed them with bread from 1 time to 3 times per day, according to the number of visitors who want to see the fish eat.

GROWTH.—I still have the 18 which were received in 1880, 11 received later, and 15 which Joseph Penrad put in my pond. They will average about 4 pounds.

REPRODUCTION.—They have produced about 350 young, which are of all sizes and weights. By reason of an overflow some spawn was lost last year.

SALES.—I sold 250 young, at $10 per hundred, to stock other ponds with. This year I expect a great demand. I shall sell them at $5 per hundred this fall.

160. *Statement of Robert McClaskey, La Grange, La Grange Co., Ind., Oct.* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp in November, 1880, and 20 more in 1882. I have a pond covering not over a third of an acre, from 1 to 4 feet deep. It has a muddy bottom, and is fed by a spring. The spring yields water enough to keep the pond, but is not very cold. I put the first lot in a small division 1 rod square and 3 feet deep, but seeing nothing of them all last summer, I supposed them dead, and you kindly sent me 20 more last fall. The latter I put in a small inclosure, but they were swept away by a flood.

ENEMIES.—There are only a few frogs.

FOOD.—I have given them some table refuse.

GROWTH.—A few days ago I drew the water from the small pond and found 6 fish of the first lot, which were from 6 to 8 inches in length. In their close quarters I should suppose it impossible for them to grow, and wonder they are that size.

161. *Statement of Fred. Balweg, Indianapolis, Marion Co., Ind., May,* 1883.

DISPOSITION OF CARP RECEIVED.—My pond is situated 5 miles south of Indianapolis, on the Madison road, is constantly supplied with spring water, and is surrounded with beech and maple trees. I stocked the pond with 40 carp in January, 1881. These young fish were then from 2 to 3 inches long. I subsequently received 20 more, from 2 to 3 inches long, which I also put in the pond.

ENEMIES.—Recently I discovered that kingfishers dive into the pond and bring out young carp. Since then I seldom go to the pond without a double-barreled shot-gun. This month I have killed 5 of these birds.

FOOD.—So far I have not fed any of the fish. There is an abundance of food in the pond.

GROWTH.—I saw nothing of my first lot of fish until October, 1881, 10 months after they were placed in the pond, when I found 19 of the 40 carp. These 19 were from 12 to 14 inches long, and weighed 2 pounds each.

162. *Statement of the Agricultural Press, Indianapolis, Marion Co., Ind., May,* 1883.

GROWTH.—Several of the parties who received mirror carp from 2 to 2½ inches long, January, 1882, report that 9 months thereafter they were from 12 to 18 inches long.

MISCELLANEOUS.—The carp is undoubtedly the fish needed to supply the want of a food-fish adapted to the waters of any part of our Union. Experience has shown us that they grow and thrive anywhere beyond the anticipation of even the most sanguine.

Mr. Davis, of California, writes on pond culture, as follows:

"The pond should have plenty of water-cress, lily, and grass, or some aquatic vegetation in it, for several reasons. First, it gives shelter to the fish; second, there is a vast quantity of food derived from it and its accumulation; third, it is indispensable, for on it the fish deposit their spawn. The eggs are adhesive and stick or adhere to the sprigs or branches, and without this the eggs would fall to the bottom in the mud and be lost. A pond should be protected, and to do this it should have a good canal or ditch dug around it to carry all the surplus water away and not allow any overflow. This all done, we have a pond ready for the water, which may be warm or cold, fresh or salt; for the history of these fishes proves that they will adapt themselves to all waters. The warmer the water the better, even up to 100°, and the faster will be the growth of your fish. The water should be kept at or near a uniform depth. The flow of water is immaterial, so that there is plenty of life in it."

163. *Statement of William A. Schofield, Indianapolis, Marion Co., Ind., Oct.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—I received 19 carp, only 9 of which were alive. About March 1, 1883, I cut the ice on the pond and placed the carp therein. I saw no signs of them to May 28, 1883, though I was informed by two of my hands that they saw one on two different occasions. The maximum depth of the water is 6 feet.

ENEMIES.—My pond appears to be alive with bull-frogs and tadpoles. It also contains two mud turtles, which with the frogs and tadpoles I fear will destroy the carp.

GROWTH.—The 9 carp received in good condition last spring have grown finely.

164. *Statement of William Zook, Denver, Miami Co., Ind., Nov.* 3, 1883.

GROWTH.—I drained my pond this fall, and found 7 of the carp which you sent me 2 years ago, which are now from 16 to 17 inches in length. What became of the rest I do not know, unless the kingfishers speared them.

165. *Statement of Calvin Fletcher, Spencer, Owen Co., Ind., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1879, I put 15 carp in a pond 33 by 80 feet and from 4 to 6 feet in depth. The bottom is composed of sand and mud, with some clay. About 600 gallons of water flow through it per hour. The summer temperature is 60° at the inlet and 80° at the outlet. In 1881 it reached 90°; in 1882, 75°.

PLANTS.—The pond contains horse-mint, white lily, and coarse border grass, hybiscus, cat-tails, and bulrush.

ENEMIES.—A few frogs will slip in. The sun-fish have escaped all our efforts at extermination.

FOOD.—From July to the 1st of October I give them boiled potatoes mashed, with one-eighth part of shorts or flour. I also feed stale bread and scraps in general.

GROWTH.—There are 4 left, which weigh from 10 to 12 pounds each. December 26, 1880, I estimated the weight of my 5 carp remaining at $2\frac{1}{4}$ pounds, and the same 5, April 8, 1882, then fully 2 years old, weighed, respectively, $6\frac{1}{2}$, 8, 8, $8\frac{1}{4}$, and $8\frac{1}{8}$ pounds. They made their greatest growth the second year. They have produced no young, as all were females.

166. *Statement of Thomas M. Browne, Winchester, Randolph Co., Ind., Sept.* 25, 1882.

GROWTH.—The carp sent into this district are doing splendidly. Their growth astonishes everbody.

167. *Statement of John W. Nighbert, Elrod, Ripley Co., Ind., Sept.* 25, 1882.

GROWTH.—I received some young carp November 28, 1881, which are doing finely. There are plenty of them 1 foot long, and I think they will weigh 1 pound each.

168. *Statement of John Fisher, Liberty Mills, Wabash Co., Ind., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp in the fall of 1879. The pond dried up and the fish all froze to death. In 1881 I received 30 more and put them in a pond containing $1\frac{1}{2}$ acres, fed by springs with water from 1 to 7 feet in depth. The bottom is muck and gravel.

PLANTS AND ENEMIES.—The pond contains moss, wild rye, and wild grass, and also minnows and frogs.

FOOD.—I give them bread and unground wheat 2 or 3 times a week.

GROWTH.—I still have 29 of the 1881 lot which will average from 3 to 4 pounds.

REPRODUCTION.—The young carp are very plenty and will amount to thousands. They are from 1 to 6 inches in length. I have let 3 other men have some to stock ponds with. There has been no trouble except with my dam.

INDIAN TERRITORY.

169. *Statement of W. J. B. Lloyd, Caddo, Choctaw Nation, Ind. Ter., Dec.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—I have several times enlarged my pond until it is now 90 feet wide and long and 4 feet deep in the center. I put the young carp in it but cannot tell how many lived. I have seen 5 or 6 of them at a time. They are playful and feed greedily, but I have as yet seen no young.

IOWA.

170. *Statement of S. W. Coffin, Fairfield, Jefferson Co., Iowa, May* 29, 1884.

DISPOSITION OF CARP RECEIVED.—June 17, 1882, I planted 3 small carp, 2 inches long and a little larger than a knitting needle.

FOOD.—The sound of my voice is sufficient to bring them to the surface of the water, and a whistle causes them to come for food. For this they scamper through the water like so many pigs. They disappear as suddenly at the voice of a stranger.

GROWTH.—They are now from 15 to 18 inches long, and will weigh from 5 to 6 pounds.

171. *Statement of Hon. James F. Wilson, Fairfield, Jefferson Co., Iowa, Apr.* 19, 1884.

DISPOSITION OF CARP RECEIVED.—In 1882 I placed 7 small carp in my pond, and also 20 more in the autumn of 1883. The pond is about 150 feet in length, by say 75 feet in extreme width, and has a depth of from a few inches up to 12 feet.

ENEMIES.—No other fish than carp are kept in the pond.

GROWTH.—During the breaking up of the ice this spring an original carp was found near the shore that measured 21 inches from head to tail, and weighed 5¾ pounds. The smaller ones of the plant of 1883 were about 9 or 10 inches long. The growth of the carp would indicate that the pond is well adapted to them.

MORTALITY.—I think all of the carp are dead. Fifteen or sixteen dead carp were found near the shores where the ice melted away, but no live ones were seen. The cause of this mortality cannot be accounted for unless it be the severity of the past winter. Four of the original carp were found dead in the spring of 1883 at the breaking up of the ice.

MISCELLANEOUS.—Presuming that so great a body of water for so few fish would not require the cutting of air-holes in the ice, none were cut. I have another pond stocked with a variety of fish, and there are great numbers in it, and all do well. No openings were cut in the ice in this pond.

172. *Statement of B. F. Shaw, Anamosa, Jones Co., Iowa, Feb.* 14, 1882.

GROWTH.—Some of the carp received on July 1, 1880, for distribution were kept in cold spring water until about May 1, 1881, when they were removed to our carp ponds. While in the cold spring water they grew but little. They were from 10 to 14 inches long in November, 1881, six months after being removed from the cold water. They were fed entirely on purslane from the garden, the leaves of which they ate with great relish.

173. *Statement of G. O. Hilton, Keokuk, Lee Co., Iowa, Nov.* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The carp which I received last February I placed in the new pond. A few of them died soon after, but a dozen of the larger ones, about 3 inches long, lived, and have done finely.

FOOD.—During the latter part of the summer and the fall they were fed on green sweet-corn shaved from the cob. They relished this very much and became very tame.

GROWTH.—They appear to be over a foot in length now. We have been much interested in watching them and seeing them do so well.

174. *Statement of John Johnston, Lisbon, Linn Co., Iowa, July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 10 carp about 3 years ago and put them in a pond 50 feet long, 20 feet wide, 3½ feet deep, with a bottom of muck. About 108 gallons of water per hour flow through it, of which the temperature at the inlet is 50°, and at the outlet from 65° to 70°.

PLANTS AND ENEMIES.—It contains moss and rushes; no fish, but plenty of small frogs. Soon after putting the fish in I discovered a mink, and caught him with a trap; also, a large snapping-turtle was shot.

FOOD.—When I first received them I fed them with cabbage, cracked corn, peas, and bread crumbs.

MISCELLANEOUS.—After a few days they disappeared, and I have not seen anything of them since.

175. *Statement of Capt. W. H. Kitterman, Ottumwa, Wapello Co., Iowa, Mar.* 14, 1884.

GROWTH.—On examining my pond lately I found the carp, which were about 3 inches long last spring, to measure from 12 to 15 inches in length.

176. *Statement of P. Thorson, Ossian, Winneshiek Co., Iowa, Oct.* 24, 1882.

REPRODUCTION.—I have a good supply of carp. In July there was a lot of young carp to be seen in the pond.

KANSAS.

177. *Statement of A. W. Crawford, Humboldt, Allen Co., Kans., Oct.* 19, 1882.

DIFFICULTIES.—During a heavy freshet my carp, and those of S. J. Stewart, were swept into a lake containing other varieties of fish.

178. *Statement of John Merhle, Atchison, Atchison Co., Kans., Oct.* 18, 1882.

DISPOSITION OF CARP RECEIVED.—I placed the carp in my pond, 20 by 40 yards, with an average of 4 feet deep, and a bottom of rock and gravel, and supplied by a strong living spring. I have watched patiently, but have been unable to see any of them.

PLANTS.—The pond is supplied with aquatic plants.

ENEMIES.—The fish in my ponds consists of buffalo, catfish, sun-fish, bass, and perch. I seined my pond July 4 last, and caught buffalo and catfish weighing 25 pounds.

179. *Statement of W. C. Rose, Uniontown, Bourbon Co., Kans., Feb.* 11, 1884.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in the fall of 1881, and my pond not being ready I kept them in a cistern until spring. May 20, 1882, I put the remaining 15 in a pond covering 9 acres. About 60 days later a flood carried away 5 more of my carp.

GROWTH.—I found one on the 24th of July which weighed a full pound. In March, 1883, I drained the pond and found 10 carp, 6 of which averaged 3 pounds in weight. The other 4 averaged 2½ pounds in weight.

DIFFICULTIES.—My pond not having been completed in the first place, the carp were kept in a cistern during the winter, and again from March to May, 1883, while I was completing the pond. During the latter time 6 more died, leaving but 4 of the original lot. Nevertheless, I procured some more in the fall of 1882. I have not seen any young carp.

180. *Statement of W. C. Rose, Uniontown, Bourbon Co., Kans., Aug.* 13, 1884.

GROWTH.—I procured some carp and placed them in my pond in December, 1880. On March 1, 1882, several of these carp weighed 3 pounds each, a growth of 3 pounds in one year. On May 1, 1884, the largest had attained a weight of 9 pounds, a growth of 6 pounds the second year. I have seen no young yet. I found below my pond July 24, 1882, one of the carp planted May 20, 1882, when it was about 3 inches long and ¾ of an inch broad. When found, it was 11 inches long and 3½ inches broad, and weighed 1 pound. This growth was attained in 64 days.

181. *Statement of M. M. Edwards, Baxter Springs, Cherokee Co., Kans., Nov.* 29, 1882.

DISPOSITION OF CARP RECEIVED.—The carp received last December were placed in a small pond near my house. I have no means of knowing to what extent they have increased in size or quantity, not being able to catch any of them. I know of their being in the pond by frequently seeing them jumping to the surface.

182. *Statement of E. D. Luts, Crestline, Cherokee Co., Kans., July* 17, 1884.

GROWTH.—On draining my pond to-day I found a carp that measured 10½ inches in length. The other carp escaped during a flood last January.

183. *Statement of Dr. George Wigg, Clay Centre, Clay Co., Kans., Mar.* 27, 1882.

VITALITY.—I have a German carp in my office that has been frozen stiff on sixteen different occasions in one month, and yet each time resuscitation has been produced after the lapse of 6 hours.

184. *Statement of E. A. Perry, Cherokee, Crawford Co., Kans., Nov.* 6, 1882.

DISPOSITION OF CARP RECEIVED.—I received of Hon. A. P. Riddle, of Girard, 20 carp November, 1881, and planted them in a lake 1 mile south of Cherokee, Crawford County. The lake covers from 35 to 40 acres, and is about 6 feet deep.

GROWTH.—The carp are doing well. I have not seen them in the last 10 days, but I should judge they were 12 inches long. These fish were from 1 inch to 2 inches long when planted.

185. *Statement of F. Z. Butcher, Solomon City, Dickinson Co., Kans., July* 14, 1883.

DISPOSITION OF CARP RECEIVED.—In 1880 I received 7 leather carp, which I lost in the fall. In 1881 I received 10 scale carp. My pond is 30 by 50 feet, 4 feet deep, with a muddy bottom, and is made by excavating the sides of a creek some 150 feet. I dammed the creek to get water to irrigate my garden, taking water from the top of the dam. Its temperature is always warmer than that of the creek. I have a large pond in which I am at present breeding buffalo.

PLANTS.—The pond contains algæ, sagitaria, flag, and several varieties of rushes. I have collected water-cresses and all the water-plants I could find in other ponds and streams.

ENEMIES.—I have tried to keep out other fish, but sometimes a bull-head or a sun-fish gets in.

FOOD.—I have fed them regularly with the millet seed, corn, wheat, &c.

GROWTH.—Those received in 1881 were from 11 to 14 inches long when I lost them.

DIFFICULTIES.—My first fish were lost by the creek overflowing. This I remedied by making a bank around the pond. Three weeks ago my boys, to see and handle the carp, waded in the water, which was not over a foot deep, and so disturbed the muck and liberated so much gas that we found 9 out of the 10 dead. These would undoubtedly have produced thousands of young this year. These were the scale carp.

TO AVOID A SOFT OR MUDDY TASTE OF CARP.—We catch large buffalo-fish sometimes in summer, in hot weather, out of ponds with muddy bottoms. To prevent the muddy taste that some complain of in carp, I find this the best way: Kill the fish as soon as caught, clean directly, soak in ice water a few minutes, then sprinkle with salt slightly, and hang up to dry. The above will make them *firm, sweet, and good.* I know whereof I speak, as I have bought, dressed, and sold fish for 10 years; and those who complain of carp, if dressed and served as above, would not know them as the same fish.

186. *Statement of O. Edwards, Doniphan, Doniphan Co., Kans., Nov.* 1, 1882.

DISPOSITION OF CARP RECEIVED.—I deposited the carp received March 1, 1882, in a pond, supplied with a spring, on a high prairie. This pond can be drawn and cannot overflow, and is supplied by springs that never fail.

GROWTH.—I procured an old seine, 5 by 30 feet, and one haul of it developed the fact that the carp were still in the pond; for they went over and under the rotten seine like beetles through a spider's web. After repeated efforts, I succeeded in capturing one and in seeing some 4 or 5 more. This carp was about one inch long last winter; now it weighs 3 pounds and 2 ounces, and measures 17 inches. To all appearances they are all the same size.

187. *Statement of J. D. Griffith, Clear Creek, Ellsworth Co., Kans., Oct.* 16, 1882.

PLANTS.—The pond in which I placed 10 carp, in May, 1881, contains a fine growth of aquatic plants.

ENEMIES.—Turtles got into the pond, and I drained it to-day to get them out.

FOOD.—My carp have received no artificial food.

GROWTH.—The pond was seined September 10, 1882, and 7 of the original carp taken. In less than 4 months these fish have grown to be a trifle over 2 pounds. To grow from a little minnow of about 2 inches to a fish of 2 pounds' weight is remarkable. We caught several old carp to-day which weighed from 3½ to 4 pounds.

REPRODUCTION.—This season my carp commenced spawning quite early, the first spawn being discovered about the middle of April. I found it to consist of a glutinous substance sticking to some brush in the water. Upon holding it so that the light would pass through the mass, I discovered that it contained living objects. I placed the substance in a tumbler of water, and in a short time I had 9 as sprightly little fish as are to be seen. My pond during the early part of the summer seemed alive with small carp, and we could dip them up in buckets when after water. As soon as they attained some size they disappeared, since which time they have not been seen until to-day, when we caught 200 at one haul of a seine.

DISPOSITION OF YOUNG.—I have distributed to several of my neighbors about 100 young carp to stock their ponds, and can furnish some for the purpose of stocking streams.

188. *Statement of D. B. Long, Ellsworth, Ellsworth Co., Kans., Sept.* 10, 1882.

GROWTH.—About the first week in May I put the 8 carp in a pond. They were about 3 inches long at that time. To-day I captured 7 of them, averaging 16 inches in length and 4½ inches in depth. I believe they would average 2 pounds in weight.

189. *Statement of Benjamin Shaffer, Ellsworth, Ellsworth Co., Kans., Oct.* 15, 1882.

GROWTH.—I caught 3 carp this fall in Smoky Hill River that weighed about 2 pounds each and measured 16 inches. They had escaped from the State ponds.

190. *Statement of T. S. Hanway, Lane, Franklin Co., Kans., Oct.* 10, 1882.

DISPOSITION OF CARP RECEIVED.—I placed my carp received December 3, 1881, in a pond 75 by 80 feet, constructed by the side of a spring branch and fed by two pipes. It was so constructed that I could admit the water into it at will. The surplus water passes out, and the pond does not fill up and the water run over as when dammed. I built a second pond this summer, which is 75 by 150 feet, and when full will be 6 feet deep. It is also at the side of the branch connected like the first. I saw the carp for the first time about the middle of last May.

ENEMIES.—Cranes and coons caught some of the carp.

FOOD.—My little boy, 10 years old, now feeds them every day, and has them so tame that they will come like pigs when he calls and eat out of his hand; fine sport for boys. I give the carp corn, apples, potatoes, and the refuse of the kitchen. They are enormous eaters.

GROWTH.—I have 20 fine-looking carp, some of which I caught the 10th of last August. They measured 13 inches in length and 3½ in depth, and weighed 2 pounds.

191. *Statement of A. A. Moore, Dennis, Labette Co., Kans., Aug.* 10, 1884.

GROWTH AND PRODUCTION.—I placed 20 carp in my pond in December, 1883, and on drawing off the water yesterday I found only 2 old carp, which, however, weighed over 1 pound each. There were also in the pond 137 young 2 inches long. My carp had no care at all, and I was surprised to find any in my pond, as it froze almost solid last winter.

192. *Statement of Chas. A. Dow, Hartford, Lyon Co., Kans., Nov.* 16, 1882.

DISPOSITION OF CARP RECEIVED. I received 20 carp last December in good condition. I made a pond by damming a small ravine. About 10 rods above the first dam I made another, to turn the surplus water into a ditch running around one side of the pond and emptying into a ravine below. When full, the maximum depth of the pond is about 6 feet. In September I had to put the carp into a small creek flowing into the Neosho River.

GROWTH.—In September, 15 of the carp averaged fully 10 inches in length.

DIFFICULTIES.—The water leaked out of the pond beneath the dam. The dryness of the summer compelled me to remove the carp to the creek.

193. *Statement of John Pickering, Fontana, Miami Co., Kans., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in November, 1880, and 20 more in November, 1882. My pond covers 1¼ acres with depth of 2 to 11 feet, with a bottom of mud and clay. It is entirely dependent on surface water from a 40-acre

pasture lot. The water gets quite warm during the summer, but is always cold at the bottom.

PLANTS.—I sowed wild rice in it, but the stock having access to it kept it clear of all vegetation.

ENEMIES.—There are perch, frogs, turtles, crayfish, and muskrats in the pond, and it is impossible to keep them out, as the pond cannot be drained. I cannot get clear of them, but I intend to make a pond that can be emptied and put another lot of fish in it.

FOOD.—I have fed the carp with bread, soaked corn, and vegetables, both raw and cooked. I generally feed them every night at sundown.

GROWTH.—I counted 5 of the original lot the other day. One of them got washed out last June which weighed 8¾ pounds. I have not seen any young yet.

DIFFICULTIES.—The great difficulty, as stated above, is to get rid of enemies. The second supply of fish was put in a new pond, from which musk-rats let the water out during the winter, and the carp froze to death.

194. *Statement of O. S. Munsell, Council Grove, Morris Co., Kans., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received 12 carp about three years ago. My pond was 30 by 200 feet, with a maximum depth of 6 feet. It was supplied with water from what was supposed to be an unfailing spring.

GROWTH.—The fish did well and grew rapidly.

DIFFICULTIES.—The cray-fish undermined the dam in spite of all we could do, and we lost the carp; the spring also failed after a protracted drought. I have faith in carp, and would try it again had I an unfailing water supply.

195. *Statement of A. Oberndorf, jr., Centralia, Nemaha Co., Kans., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received about 30 carp in 1880, and put them in a pond made of a slough about 25 by 30 feet and from 3 to 6 feet deep. The wall of the pond caved in the spring after I received the carp, and I suppose if any were left they fell a prey to the catfish, which are numerous in the slough. The experiment has been too expensive to repeat it. I fed them with mush, as directed.

196. *Statement of Thomas B. Sears, Churchill, Ottawa Co., Kans., Oct.* 14, 1882.

CARP IN SALINE RIVER.—The heavy rains of last spring washed out my pond, and I suppose my carp are now in Saline River.

197. *Statement of L. Defenbaugh, Arlington, Reno Co., Kans., Oct.* 24, 1882.

DISPOSITION OF FISH RECEIVED.—I shall change my carp into another pool in the spring, as there are thousands of other fish with them. I have two ponds, and intend to build a third.

GROWTH.—On draining the pond a few days ago I found 19 carp, as pretty fish as I ever saw. Some were 16 inches long, weighing about 2 pounds each. They have not spawned this year.

198. *Statement of Charles Reynolds, Arlington, Reno Co., Kans., Oct.* 16, 1882.

GROWTH.—I received the fish last fall. I am greatly surprised now to find that carp 2 or 3 inches long should in so short a time grow to their present size of from 16 to 18 inches in length. They were received last fall.

REPRODUCTION.—I have seen a lot of small ones of this summer's spawning, all of which are doing well.

199. *Statement of G. R. Jones, Hutchinson, Reno Co., Kans., Oct.* 12, 1882.

GROWTH AND REPRODUCTION.—The carp received one year ago will average from 15 to 18 inches long. There is a fine lot of young.

200. *Statement of A. Clark, Nickerson, Reno Co., Kans., July* 1, 1884.

GROWTH AND REPRODUCTION.—November 25, 1882, I received 20 carp, which are now from 16 to 18 inches long. They have not spawned yet, but I have placed some limbs of box-elder with leaves and seed on them in the pond, hoping to catch the spawn.

201. *Statement of editor of Industrialist, Manhattan, Riley Co., Kans., Sept. 23, 1882.*

DISPOSITION OF CARP RECEIVED.—We have 2 ponds, in one of which we placed our carp, April 22, 1882.

ENEMIES.—Perhaps the cray-fish, which are numerous, consumed the eggs of the young fish, though the carp are only a year and a half old.

GROWTH.—Under the influence of hot and dry weather the pond became very shallow, scarcely a foot in depth. We availed ourselves of the unusually good opportunity for drawing the pond and inquiring into the condition of our carp. On Thursday we found the carp had developed into magnificent specimens, some averaging 16 inches in length and weighing, by actual test, from 2¼ to 3 pounds. To show how rapidly the carp gained, we will remark that these fish, with the most ordinary care, or for the most part no care at all, have doubled in weight since last April.

202. *Statement of E. L. Patee, Manhattan, Riley Co., Kans., Nov. 15, 1882.*

DISPOSITION OF CARP RECEIVED.—I put the carp in a large tub 4 feet deep by 6 feet across the top. In this tub I put stones and some dirt, allowing ½ inch stream of water to run in it. The cold weather killed all but 4, which I subsequently placed in Eureka Lake. I am satisfied that carp will do well if cared for.

203. *Statement of E. M. Shelton, Manhattan, Riley Co., Kans., Oct. 11, 1882.*

FOOD.—I sometimes feed the carp once a week. I find they can be raised with much less trouble and expense than chickens.

GROWTH.—The carp were 2 inches long when received, April 18, 1881. Last April I seined the pond and captured 10 carp weighing 1½ pounds each and measuring 13 inches in length. They have fully doubled in weight during the past 6 months, and at this writing they will turn the scales at 3 pounds.

DIFFICULTIES.—I have never known of the death of but 1 of my carp, and that happened shortly after the fry were received.

204. *Statement of J. F. Buck, M. D., North Topeka, Shawnee Co., Kans., Feb. 5, 1884.*

DISPOSITION OF CARP RECEIVED.—The 21 carp I received in October, 1879, were then from 2 to 2½ inches in length, and having been kept in the cellar until the next May, were placed in a pond of the Fairmount Children's Home, near Alliance, Ohio. The pond is 150 by 400 feet, has a muddy bottom, and is very well supplied with spring water.

PLANTS.—The pond was very full of water-grasses and weeds.

ENEMIES.—The pond was cleaned out about May, 1882, as it became infested with turtles. A part of the fish were taken during the first season by thieves.

GROWTH.—In October, 1882, Mr. J. K. Neisz, my successor, told me one of the carp weighed 5 pounds, and that 5 others weighed 20 pounds. They were then 2 years old.

MISCELLANEOUS.—When the pond was drained some of the fish passed down the spring brook. With anything like ordinary care they would have been a grand success.

205. *Statement of Rev. D. H. Welch, Macksville, Stafford Co., Kans., Aug. 20, 1883.*

DISPOSITION OF CARP RECEIVED.—I received some carp about June, 1879, and some more last fall. My pond, when full, covers from 1½ to 2 acres, and has a muddy bottom. It only gets filled up when there is a freshet. It contains no special kinds of plants.

ENEMIES.—It contains frogs and common water turtles.

DIFFICULTIES.—The first lot froze to death in the winter of 1879–'80, at which time they weighed about 2½ pounds each. The greatest difficulty has been to keep water enough in the pond and keep it open in winter. I do not know what the last lot is doing, and am satisfied they will prove a grand success if well taken care of.

206. *Statement of Henry A. Troeger, Levy, Sumner Co., Kans., Dec. 9, 1882.*

GROWTH.—We received a can of carp nearly a year ago. We saw nothing of them all summer and concluded that they had all died from effects of their journey. Our dam at the lower end of the pond did not seem high enough for us during our continued rainy weather last spring, so we dug an outlet at one side through our meadow, and a few fresh fish found their way up into our pond in spite of the wire screen which we had put in to keep them out. When the water got low last fall we seined out 3 nice carp 15 inches long. How many more there may be in the last mentioned portion of the pond we do not know.

207. *Statement of John W. Chandler, Wellington, Sumner Co., Kans., Nov.* 20, 1882.

DISPOSITION OF CARP RECEIVED.—The carp received in November and December last were placed in a pond covering 3 acres, which was formed by running a race from the mill dam into it.

GROWTH.—These carp are now from 14 to 17 inches in length, are fat and plump, and will weigh 3½ pounds. We have seen no evidence of their spawning. We can raise carp cheaper than we can beef or pork.

208. *Statement of Geo. F. Nealley, M. D., Collyer, Trego Co., Kans., Oct.* 23, 1882.

DISPOSITION OF CARP RECEIVED.—The twenty carp received a little less than a year ago I placed in a pond 1 rod square, supplied by a spring of cold water. This fall I transferred the carp to a larger and more shallow stream near the smaller one, and allowed the water to stand a while and run from the former into the latter.

GROWTH.—On draining the small pond this fall I found the entire original number of carp, but they had not increased in size, which fact I attribute to the cold water. In the larger pond, in which I lately placed them, I anticipate more favorable results. At the date of the transfer, it was estimated that their weight was a half-pound each, and their length about 8 inches.

KENTUCKY.

209. *Statement of James M. Bell, Lawrenceburg, Anderson Co., Ky., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 24 carp in November, 1881. My pond covers ¾ of an acre, is from 10 to 12 feet in the deepest part, and has a muddy bottom. It is fed by springs.

PLANTS AND ENEMIES.—A grass with a broad stem grows about its edges. It also contains catfish, turtles, and frogs.

GROWTH.—I have seen about 7 or 8 of them and should think they would weigh from 7 to 8 pounds apiece, but I never saw anything of them until about one month ago. They appear to be about 18 inches in length.

MISCELLANEOUS.—I have never fed them. I supposed they spawned last spring. I have never taken any care of them, and flatter myself that by next summer I shall have some nice fish to eat.

210. *Statement of O. A. Gilman, Paris, Bourbon Co., Ky., Aug.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—I received 5 carp of one kind and 7 of another in November, 1881. My pond is nearly round, averages 150 feet wide and 4 feet deep. The bottom is of yellow clay and limestone rock. The water is derived entirely from rains. It is situated in the rear of the barn and much of the wash of the yard runs into it.

PLANTS.—It contains no water plants. Willows grow around it.

ENEMIES.—By mistake some perch got into the pond, but I do not think they will be deleterious to the carp.

FOOD.—We have been giving them bran and meal mixed in balls often. They are also fond of vegetable matter.

GROWTH.—I think there are 3 or 4 of the scale carp and 2 or 3 of the mirror carp. I caught 5 in May last, 2 of which weighed, before being dressed, 5½ and 7 pounds, respectively. These were 3 years old. The 3 others were about a year old and weighed about 2 pounds each. The yearlings now weigh from 2 to 2½ pounds each.

REPRODUCTION.—I cannot tell how many, but there look to be quite a large number of young, from 2 to 3 inches long. I have supplied some of my neighbors with young. I have also stocked another pond with some of the yearlings.

HOW TO CATCH CARP.—They bite readily at small hooks baited with worms, the same as the suckers do.

211. *Statement of J. G. Stephens, Holt, Breckenridge, Co., Ky., Aug.* 5, 1881.

DISPOSITION OF CARP RECEIVED.—I received the 20 carp last April, when they were from 3 to 5 inches long, and the largest not exceeding 1½ ounces in weight. Before placing them in the pond 2 died. I still have 6 leather and 10 scale carp.

PLANTS AND FOOD.—The pond is devoid of vegetable matter. I fed the carp only 2 or 3 times.

GROWTH.—I measured the largest, a leather carp, this morning, and found it to be 12 inches long. It would have weighed 1½ pounds, this extraordinary growth being attained without any extra attention on my part.

MISCELLANEOUS.—I do not see why carp cannot be raised as cheaply as chickens and ducks.

212. *Statement of C. T. Allen, Princeton, Caldwell Co., Ky., Aug.* 26, 1881.

DISPOSITION OF CARP RECEIVED.—The 20 carp, received in good order December 15, 1880, I placed in an excellent pond of good water. The pond is a deep one, and from 30 to 40 yards in diameter.

FOOD.—I did not feed the carp.

GROWTH.—I seined the pond day before yesterday, and caught a carp which measured by the rule 14½ inches in length and weighed from 1½ to 2 pounds. I caught only 1, but am confident the remainder are alive and doing well.

213. *Statement of J. H. Ritchey, Burkesville, Cumberland Co., Ky., Jan.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—About this time last year I received a can of carp. My pond was dug in a marshy place, with a bottom composed of a stiff blue clay, 8 or 10 inches deep, which became soft after being under water since last April. The pond is fed by a spring, is about 4 feet deep and 40 feet wide by 100 feet long. The stream at this time will furnish 500 gallons of water in 24 hours, and the water is running over the dam. The pond in which I now keep them is a new one with stiff yellow-clay bottom and sides.

FOOD.—During the warm weather they were fed regularly on bread, wheat, and corn, for which they came to the top of the water. Since the 1st of October I have not seen any of them, but I still continued to give them about one-fifth as much feed as they had previously. It seems they had not eaten any of it, and I suppose there was about ½ bushel of food in the pond.

GROWTH.—Three of my carp weighed 2½ pounds each; others are much larger, one weighing 4 pounds.

DIFFICULTIES.—A few days ago I discovered a few of them sick, floating on the water. I caught them and placed them in another pond, and in a few hours they seemed to be well. Others were discovered to be sick during the day. I then drained the pond as rapidly as I could, and at the close of the second day had the water all out, but by this time all my fish were sick and three of them had died. I cut open the dead ones, but failed to find anything wrong. They were entirely empty, not one particle of food or mud being in them. Could it be possible that the decayed food in the pond poisoned them, or was the poison generated in this blue mud in the pond?

214. *Statement of Alex. Jaffrey, Lexington, Fayette Co., Ky., Sept.* 20, 1883.

DIFFICULTIES.—Musk-rats destroyed my dam, leaving so little water that the heron and minks gobbled the young carp before they were 2 inches long.

215. *Statement of James H. Mulligan, Lexington, Fayette Co., Ky., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—Three years ago I received 30 carp, and in the autumn of 1882, 10 more. My pond is circular in form, 100 feet in diameter, 30 inches in depth, and has a rocky bottom with a deposit of from 4 to 6 inches of soft mud. The water is from limestone and is hard. It comes from a spring 50 feet distant at the rate of from 40 to 60 gallons per minute. Its temperature in summer is from 40° to 45°.

PLANTS.—It contains no plants, except green moss growing from the bottom and the fine roots of willows which stand on the banks.

ENEMIES.—It contains some frogs, some white and black perch, which it seems impossible to exclude.

FOOD.—At very irregular intervals in summer I feed them on vegetable scraps, boiled corn, &c.

GROWTH.—I still have 11 of the first lot, which will weigh from 6 to 8 pounds each. Those of the second lot are from 6 to 8 inches in length.

DIFFICULTIES.—I am afraid that the eggs, like those of the trout which I had previously tried, would not fecundate in the cold limestone water.

216. *Statement of William Warfield, Lexington, Fayette Co., Ky., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received 8 carp in June, 1880, and 21 in November, 1880. My ponds are 150 yards long by 40 feet wide and 16 feet deep, with a muddy bottom. The ponds are fed by a constant stream of water from 4 to 24 inches, according to the season. They contain no plants.

ENEMIES.—They contain the ordinary perch and croppy. Common mud-turtles and frogs are occasionally found in them.

GROWTH.—I have caught with a seine several of the old ones. They grow very fast and weigh from 12 to 15 pounds each. I have seen no young ones.

217. *Statement of Robert D. Allen, Farmdale, Franklin Co., Ky., Oct.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 40 carp in the fall of 1881 and have received 20 since. My pond has a muddy bottom and is fed by springs as well as the drainage from 50 acres of land. It is not very cold.

ENEMIES.—It contains new lights (a game fish), sun-fish, catfish, frogs, turtles, &c.

GROWTH.—One of the old ones which was handled this summer weighed 10 pounds and was 2½ feet long.

REPRODUCTION.—They have produced many, very many, young. We can see hundreds.

218. *Statement of A. W. Overton, Frankfort, Franklin Co., Ky., Aug.* 11, 1883.

DISPOSITION OF CARP RECEIVED.—I received 30 carp about a year and a half ago. I have kept them in a pond about 3 feet deep, fed by a spring. The water from the spring runs in a moderate stream and is of the usual temperature of spring water.

ENEMIES.—The pond contains no fish, frogs, nor turtles.

GROWTH.—I still have the 30 carp, one of which, taken 2 months ago, measured 22 inches in length. I have given them very little if any food. They have produced no young. They have given me no trouble.

MISCELLANEOUS.—Col. R. D. Allen, superintendent of the Kentucky Military Institute at Farmdale, Franklin County, has had carp from 2 to 3 years and has the finest pond in the county. The carp he first received are increasing very rapidly; so fast, indeed, that he thinks of trying to check the increase. His largest carp weighs 10 pounds and he is delighted with their food qualities.

219. *Statement of John Richards, Nolin, Hardin Co., Ky., Apr.* 15, 1882.

GROWTH.—A leather carp weighing 5¼ pounds and a scale carp weighing 4 pounds from my pond were exhibited to the members of the legislature a few days ago. These fish were planted in my pond April 17, 1881.

220. *Statement of T. J. Megibben, Cynthiana, Harrison Co., Ky., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received some carp in 1881, and the dry summer of that year dried up the pond, and the fish perished.

221. *Statement of Garnett Burks, Hardyville, Hart Co., Ky., Aug.* 16, 1883.

DISPOSITION OF CARP RECEIVED.—April 10, 1881, I received 3 scale carp and 2 leather carp; they were then 3 to 4 inches long. November 9, 1881, I received 16 more leather carp.

GROWTH.—In August, 1881, a boy killed one of the first lot, which was 16 inches long, 11¾ inches around the body, and weighed 1¾ pounds. August 3, 1881, I transferred the other 4 to another pond; they were equally as large as the one killed. To-day I caught a leather carp and measured it. It was 24 inches in length and 17¼ inches around the dorsal fin and weighed 10 pounds. The weighing and measuring were witnessed and certified to by S. G. Renfro, William McCaulley, and S. W. White, citizens of Hardyville.

222. *Statement of E. S. Edwards, Horse Cave, Hart Co., Ky., May* 20, 1883.

GROWTH.—The 3 carp placed in my ponds 14 months ago now average 6 pounds in weight.

223. *Statement of C. J. Walton, M. D., Munfordville, Hart Co., Ky., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp in 1880 and again in 1881, which I distributed to the farmers for their ponds, called basins or sink-holes. These are from 3 to 15 feet deep, have muddy bottoms, and contain lilies, flags, &c.

ENEMIES.—They also contain catfish, sunfish, toads, and frogs.

GROWTH AND REPRODUCTION.—These carp now weigh from 5 to 7 pounds, and there has been a large increase. They are eagerly sought after and now take precedence of all other fish.

DIFFICULTIES.—In one pond located in a horse lot all the carp died.

MISCELLANEOUS.—Our county is almost wild with the carp excitement, and the demand is so heavy that we cannot by any means supply it. There are lots of large basins, "sink-holes," and carp-raising in them is bound to thrive.

224. *Statement of J. L. Woolfolk, Madisonville, Hopkins Co., Ky., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received 43 carp in September, 1880, and put them in a small pond 25 feet square with 3 feet of water. One-half of it is stone bottom and the other half muddy bottom. I can turn in the water at pleasure, and, having filled the pond, cut it off.

PLANTS AND ENEMIES.—It contains grass and dock and a few sun-perch.

FOOD.—I sometimes fed them with liver and baked bread.

GROWTH.—I had 33 of the carp when I drained my small pond, which measured from 6 to 8 inches in length. I have found no young ones. I think the boys have caught a few of the carp.

MISCELLANEOUS.—Last fall I went to Florida and there was but little care taken of them. After the small pond was drained I threw the carp into the big pond with the other fish.

225. *Statement of L. Washburn, Lyndon, Jefferson Co., Ky., Aug.* 20, 1881.

GROWTH.—When I placed the carp in my pond, April 9, 1881, they were from 2 to 4 inches long. August 10, 1881, just 4 months after planting them, they were 13½ inches long and weighed 34 ounces. I fed the carp.

226. *Statement of Geo. K. Speed, Louisville, Jefferson Co., Ky., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in the spring of 1881, and 20 since. My pond covers 4 acres, and averages 4 feet deep, and is fed by several springs. It contains no grasses.

ENEMIES.—The pond contains bachelor-perch, sun-fish, catfish, and frogs.

GROWTH.—In the summer of 1882, there were 2 washed over the dam during the freshet, which weighed 7 pounds each and were full of eggs. I have never fed them. I do not know how many are left or how many young there are.

DIFFICULTIES.—The only difficulty has been to keep off the poachers. The laws are good enough, but they cannot be executed.

227. *Statement of T. Jeff. Phelps, Covington, Kenton Co., Ky., April* 8, 1882.

GROWTH.—I can produce for inspection scale carp that have attained a weight of from 4 to 5 pounds, and leather carp a weight of 7 pounds, within 5 months after being placed in the pond.

228. *Statement of Thos. W. Roane, M. D., Covington, Kenton Co., Ky., Oct.* 9, 1882.

DISPOSITION OF CARP RECEIVED.—I received 40 carp last November and placed them in a pond dug in rich alluvial ground and fed by springs.

ENEMIES.—On the 6th instant my pond was bored into by craw-fish, and when the stream of water was noticed an immense number of very small fish, measuring from ¼ to ½ inch long, with large heads, were observed coming out in it.

FOOD.—The carp feed most greedily and devour anything I give them, such as corn, wheat, bread, potatoes, fruit, &c.

GROWTH.—The carp have grown exceedingly. One I took with hook and line, to my astonishment, weighed 3 pounds, and I am sure it was not the largest.

REPRODUCTION.—I am delighted to be assured of the carp breeding so young and in such a quantity. There must be thousands of them in my pond.

229. *Statement of A. Shinkle, Covington, Kenton Co., Ky., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in December, 1881, and some more two or three times since. I have two ponds, one 250 yards long and 100 feet wide and 18 feet deep, with clayey bottom; and another pond, not so large, exclusively for carp. It is 8 feet deep, with a bottom of clay and grass. The water is quite cool and overflows 6 months in the year.

PLANTS.—The pond contains a heavy wild grass, with blue grass surrounding it.

ENEMIES.—The large pond contains black bass, white perch, new light, sun-perch, rock-bass, and pickerel.

FOOD.—I fed the carp with stale bread and vegetables. They are so well fed that they will not bite at a hook.

GROWTH AND REPRODUCTION.—I think some of the old ones would weigh 10 or more pounds. There are young, but I do not know how many. I keep them in the pond and cannot catch them. They are the liveliest I have ever seen; more so than the black bass. They will not bite hooks baited with bread or worms.

230. *Statement of J. B. Briggs, Russellville, Logan Co., Ky., July* 28, 1881.

DISPOSITION OF CARP RECEIVED.—I received a lot of carp, 2 inches long, last winter, and placed them in my pond at once. In consequence of low water, I removed them to another pond the other day.

GROWTH.—When I transferred my carp they were 14 inches long and weighed 24½ ounces.

231. *Statement of W. Van Antwerp, Mount Sterling, Montgomery Co., Ky., Oct.,* 31, 1882.

DISPOSITION OF CARP RECEIVED.—I went personally and planted the carp, two years ago the 19th of this coming December, in shallow water lying fair to the sun, with brush, stumps, and old roots in it to make places for spawning.

PLANTS.—I have sown rice and transplanted water-lilies, &c., to make shade and concealment for them.

GROWTH AND REPRODUCTION.—To-day I can go to my ponds and catch carp of 7 pounds weight. Several ponds have young fry in them to the amount of many hundred thousand each.

EDIBLE QUALITIES.—We have caught quite a number to test their edible qualities, which all pronounce not excelled by any of our indigenous fishes. I always instruct the cook to clean them nicely, then wrap the fish in a linen towel, have a large kettle of water boiling, coil the fish neatly in the kettle and boil fifteen minutes, then turn off the water, remove to a baking pan without marring, and put in the oven, bake, and then baste with butter gravy. A nice dressing could occupy the interior of the fish and the space around the sides. If properly done it makes a dish fit for a king, or a hungry fisherman.

232. *Statement of R. Payne, Georgetown, Scott Co., Ky., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp in the fall of 1880. They have been kept in a pond of 1 acre, with a muddy bottom and water from 1 foot to 8 feet deep. It is fed by a medium spring.

PLANTS AND ENEMIES.—Its margin is covered with moss, and it contains perch, frogs, and turtles.

GROWTH.—Last year they weighed from 7 to 9 pounds each. I have not seen them since and there are no signs of any young. I have never fed them or paid them any attention.

233. *Statement of T. M. Hifner, Mortonsville, Woodford Co., Ky., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received 22 carp in December, 1881, but my pond overflowed and they escaped. I have since placed a screen in it. Last May I received 25 more from a neighbor. I have them in a pond about 200 feet in diameter and 4 feet deep, with a muddy bottom. It is fed by the rains and is of the temperature of the atmosphere.

ENEMIES.—The pond contains nothing else but frogs.

GROWTH AND REPRODUCTION.—Mr. J. H. Jesse, of Versailles, who placed some in his pond in December, 1881, caught one last year which weighed 6 pounds. My second lot were from 2 to 4 inches long. Those that are 2 or more years old about here are said to weigh from 10 to 12 pounds, and their minnows are very numerous.

234. *Statement of George M. Emack, Versailles, Woodford Co., Ky., July* 18, 1883.

DISPOSITION OF CARP RECEIVED.—I received 6 carp in December, 1880, and some more last November. My pond covers about 1 acre, and has a muddy bottom, and is 4 feet deep. It is fed by rains only.

ENEMIES.—It contains a few sun-perch. I do not think there are any turtles in the pond.

FOOD.—I give them barley, corn, and sometimes ground oats and rye.

GROWTH.—I think there are about 3 of the first lot remaining. I took 1 out this spring which weighed 14 pounds. Those received last November now weigh about 1 pound each. I have given them no care whatever.

235. *Statement of M. S. O'Neil and C. G. Arnold, Versailles, Woodford Co., Ky., Aug.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—We received 12 carp in March, 1881. Our pond covers 1 acre, has a muddy bottom, and is from 3 to 10 feet deep. A stream runs into it the year round, but not enough to overflow the banks.

PLANTS.—It is surrounded by blue grass and white clover, which the fish feed on when the water is high.

ENEMIES.—It contains no other fish, but there are small frogs, and but few, if any, turtles in it.

FOOD.—We feed them seldom, but sometimes on cabbage and young corn.

GROWTH.—We still have 9 of the old ones. We see them occasionally feeding close to shore, and think they will weigh from 15 to 20 pounds each.

REPRODUCTION.—It is impossible to tell how many young they have produced, but we would think millions. The first hatching will weigh from 5 to 7 pounds each. The next will weigh about a pound each. There are a great many from 1½ to 3 inches in length.

DISPOSITION OF YOUNG.—We have given our friends over 1,000 to stock their ponds.

DIFFICULTIES.—The greatest difficulty is to kill off the birds that catch the young carp, such as kingfishers.

HOW TO CATCH CARP.—They bite well at worms on the hook. We caught one with a small piece of cabbage yesterday, which weighed 5 pounds. We suppose we have caught over a thousand with hook and line. At times they bite just as well as other fish.

236. *Statement of P. G. Powell, Versailles, Woodford Co., Ky., Aug.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—I received 10 carp in December, 1880, and put them in a pond 60 by 150 feet, with a muddy bottom. It is fed from a spring with a moderate amount of water. It contains no plants.

ENEMIES.—It contains a very few white perch, a few bream, a few mud-turtles, and some frogs.

GROWTH.—I think I have 5 of the old ones which will weigh 10 pounds apiece. I have never fed them.

REPRODUCTION.—The pond is well stocked with young, the largest of which weighed from 1½ to 2 pounds last April. We have had so many that we have eaten some and given a few to a neighbor.

EDIBLE QUALITIES.—The small ones, split open and fried, are excellent The opinion of every one is that they never ate better fish. I expect to have fish every day during the season.

DIFFICULTIES.—I shall have difficulty in keeping them from becoming too numerous.

LOUISIANA.

237. *Statement of R. T. Carr, Mansfield, De Soto Parish, La., April* 3, 1882.

GROWTH.—The carp received about 2 months ago I placed in a pond known as Johnson's pond. When received they were about 2 inches long and scarcely an inch wide, and now they have attained a length of about 6 inches and a width of about 2½ inches.

238. *Statement of J. Ernest Breda, Natchitoches, Natchitoches Parish, La., Feb.* 23, 1884.

GROWTH.—Of the carp received I have now fine specimens varying from 18 to 24 inches in length. I have raised none from them on account of other fish entering, by an accident to my dam. I am preparing another pond, in order to drain the first and destroy the other fish, and then I am certain that I will make carp-culture not only a pleasure but a source of considerable profit. But for the accident to my pond I would have had for next fall over 100,000 fish over 12 inches in length.

239. *Statement of J. A. Ivy, No.* 163 *Camp Street, New Orleans, La., May* 26, 1883.

GROWTH.—The carp received January 1, 1883, are growing and doing well. From their appearance in the water, I think they weigh from 2 to 3 pounds.

240. *Statement of R. H. Yale, New Orleans, Orleans Parish, La., July* 17, 1883.

DIFFICULTIES.—The carp you furnished were all destroyed by snakes and black trout.

241. *Statement of S. V. Martin, St. Martinville, St. Martin's Parish, La., Nov.* 17, 1883.

DISPOSITION OF CARP RECEIVED.—I received 30 carp in December, 1880, and 30 more in December, 1882. My pond covers 2 acres, is from 1 foot to 10 feet deep, and has a sandy bottom. It is supplied with rain water in large quantities, and when full the water flows through an iron frame into the Teche River.

PLANTS.—Sea-rush, green turf, Bermuda grass, and other grasses grow in the pond.

ENEMIES.—The pond is inhabited by almost all the fish and turtles indigenous here.

FOOD.—I feed my carp on corn and vegetables. They thrive on any kind of food.

GROWTH.—The first lot of carp escaped into the Teche River. I have about 15 of the second lot, which weigh about 15 pounds each.

REPRODUCTION.—Many young passed through the iron frame into the Teche River. Some of the young will weigh 5 pounds.

EDIBLE QUALITIES.—I have eaten several carp served in different styles. With the exception of the red-fish and gaspereau, the carp cannot be surpassed.

DIFFICULTIES.—The iron frame between my pond and the river is not so constructed as to admit of the passage of the water and still prevent the escape of the fry.

242. *Statement of J. C. Loye, Minden, Webster Parish, La., July* 21, 1882.

GROWTH.—I saw nothing of the 20 carp received on January 9, 1882, until, when making some improvements in my pond last week, preparatory to stocking it with native perch, 3 large carp floated to the surface, killed by the muddiness of the water. By actual weight 2 of these carp weighed each 2½ pounds, and the other weighed 2¼ pounds. This extraordinary growth demonstrates that the climate and waters of the South are so adapted to the carp that they will even reach greater proportions than in their native streams in Germany. These fish are easily raised, and make a most excellent dish. Since these 3 were killed, other carp have been discovered in the pond.

MAINE.

243. *Statement of S. H. Chandler, New Gloucester, Cumberland Co., Me., July* 16, 1883.

DISPOSITION OF THE CARP RECEIVED.—I should have put the carp into a pond immediately after receiving them. I received them Saturday, and kept them till Monday in the can in which they came from Washington, and in that time they nearly all died. Either through my ignorance of the proper method of managing them, or for other reasons, it was a complete failure.

[By changing the water every few hours he could have kept the carp in the same can over Sunday.—EDITOR.]

244. *Statement of Geo. H. M. Barrett, Rockport, Knox Co., Me., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received some carp November 19, 1880, 2 inches long. The place I put them in was frozen over with ice 2 inches thick, and it was so cold I think the fish were chilled, though they were all alive when I put them in.

DIFFICULTIES.—I never saw anything of them afterwards, and do not think there was any chance for them to live, as they were so small and it was so cold. I would like to try it again.

MARYLAND.

245. *Statement of Thomas G. McCulloh, Frostburg, Alleghany Co. Md., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—In April, 1880, a friend gave me 2 scale carp, 3 inches long, which I placed in my pond. In October of the same year I received 40 leather carp. In October, 1881, I received 100 more of the same variety. The pond covers ⅘ of an acre, is 6 feet deep, and is certainly suited to the raising of carp.

ENEMIES.—The pond is infested with turtles, snakes, frogs, and kingfishers; formerly also with chubs and other small fish common in our waters.

GROWTH.—When I drained the pond for the purpose of improving it, I caught one of the first pair, which was 15 inches in length and weighed 2¼ pounds. In October, 1882, I drew off the pond again and found thousands of chubs and other small fishes, all of which I turned out. I did not drain it to the bottom, but did so sufficiently to discover the carp swimming upon the surface singly and in pairs. One which I caught, supposed to be one of the last lot received, was 15 inches long. I saw larger ones, but as I did not wish to disturb them too much, I turned on the water and filled the pond.

REPRODUCTION.—We have not discovered any little ones, and feel at a loss to know why.

246. *Statement of N. J. Watkins, in behalf of James A. Iglehart, Davidsonville, Anne Arundel Co., Md., July* 29, 1881.

DISPOSITION OF CARP RECEIVED.—The carp received in November, 1879, I placed in a pond covering about ¼ of an acre.

FOOD.—The green scum on the surface of the pond and the large quantity of vegetable matter therein afford the carp a sufficient quantity of food.

GROWTH.—Nothing was seen of the carp until February, 1881, when, on cutting ice, several large carp, averaging 15 inches in length, were stirred up from the bottom of the pond.

REPRODUCTION.—Carp 6 inches long were also stirred up from the bottom of the pond while cutting ice, and supposed to be the young of the original carp. Thousands of very small fish, which have proved to be carp, made their appearance in schools upon the surface of the water in July, 1881.

MISCELLANEOUS.—The old carp have not been seen since February, 1881, but it has been suggested that the muddiness of the pond indicates their presence.

247. *Statement of Adolph J. Gall, Jessup's, Anne Arundel Co., Md., July 27, 1883.*

DISPOSITION OF CARP RECEIVED.—On May, 1880, I received 12 leather carp 3 inches long, and May 25, 1880, 20 scale carp from 2 to 3 inches long. The leather carp have been kept in an ice pond covering ¼ of an acre, with an average depth of 4 feet, and a muddy bottom. The scale carp have been kept in an ice pond ⅛ of an acre in extent, with a depth of 2 feet, and a muddy bottom. The water supply is derived from 4 or 5 never-failing springs.

ENEMIES.—There are no water-plants and no other large fish in the ponds. There are bull-frogs in them, but I kill them whenever they appear. My most serious difficulty has been to keep off a certain bird, the so-called "kingfisher."

FOOD.—I feed the carp with bread, boiled hominy, boiled potatoes, fine-cut cabbage leaves, and lettuce leaves when in season. They are fed 3 or 4 times per week in spring, summer, and fall.

GROWTH AND REPRODUCTION.—I have 7 of the original carp left, and 10 of the scale carp. They weigh from 2 to 4 pounds. They have produced thousands of young, which vary from the size of a cucumber-seed to about ¼ of a pound. In my opinion the scale carp is far superior to the leather carp in regard to multiplying, although the latter outgrew the former by one-fourth at least, under the same care.

DISPOSITION OF YOUNG.—I have given some of the young to my neighbors, and have stocked the stream.

248. *Statement of Samuel Anderson, Rutland, Anne Arundel Co., Md., July 23, 1883.*

DISPOSITION OF CARP RECEIVED.—I received my carp in December, 1879, and put them into my mill-pond, which covers about 2 acres, and is 10 feet deep at its deepest point, gradually becoming shallow towards the upper end. The bottom is composed of soft mud. By storing it up at night, the water passing through the pond is sufficient to run a 10-horse-power wheel during the day. The temperature of the water at this time is about 60° Fahr.

PLANTS.—Quite a variety of marsh-grasses grow along shallow parts, and also water-lilies. There is grass upon the banks, which is in and out of water alternately as the pond is full or not, and upon which I have seen the carp feeding.

ENEMIES.—There are catfish in it, and a variety of very small branch-fish, snapping-turtles, and small terrapins. I fear the snapping-turtles have destroyed many carp.

FOOD.—I have very seldom fed my carp. I have placed corn-bread and other waste from the kitchen in the pond a few times, but do not know whether they fed on it or not.

GROWTH.—I do not know how many old ones I have left. About 14 months ago I caught one which had gotten out of the pond, the weight of which was 3 pounds and 6 ounces. I occasionally see one which I suppose would weigh 4 or 5 pounds. Such of the young as I have seen this summer would hardly weigh a pound.

REPRODUCTION.—I do not know how many young have been hatched. The first were seen about 15 months ago, when they appeared in the mill-race, and small ones passed through the turbine-wheel and were killed. I have seen many this summer feeding along the banks. A few have since become entangled in the obstruction which I have placed in the mill-race and been eaten by my miller. My trouble now is to know how to catch them.

249. *Statement of Marcus C. Barclay, Baltimore, Baltimore County, Md., July 23, 1883.*

DISPOSITION OF CARP RECEIVED.—Three years ago I received 20 carp, and put them in a pond of 250 acres, with a muddy bottom, 4 feet deep, and fed by springs.

PLANTS AND ENEMIES.—The pond contains lilies and rushes, catfish and goldfish.

DIFFICULTIES.—The next day after we put them in we found them all dead, floating upon the surface of the pond, and were not able to account for it. They looked as if they had been hurt.

250. *Statement of J. A. Edmondson, No. 48 South Calvert street, Baltimore, Md., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I have received two shipments, in 1880 and 1881 respectively. I have kept my carp in a pond $1\frac{1}{2}$ acres in size and from 4 to 6 feet deep, with a muddy bottom. Considerable water flows through it, mostly spring water; it is rather warm at this season.

PLANTS AND ENEMIES.—There is grass on the margin, but nothing shows above the surface of the water. There are a few varieties of small fish in the pond, a great many snappers, and some smaller kinds of turtles.

FOOD.—I give the carp garbage occasionally. I did not feed them at all before the present summer.

GROWTH.—I cannot tell how many I have left or whether they have produced any young, as they keep the water muddy so that we cannot see them. The largest which we have noticed were from 3 to 4 pounds in weight.

251. *Statement of L. Keidel, Baltimore, Baltimore Co., Md., May* 13, 1882.

GROWTH.—In 1880 I stocked a pond with 50 carp about 2 inches long, of which 20 still survive. They now measure from 15 to 18 inches each. Feeling encouraged by this success I had another pond constructed, and am anxious to secure a lot of leather carp for it.

252. *Statement of John R. Long, Baltimore, Baltimore Co., Md., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—Three years since I received about 50 carp. Unfortunately the dam leaked, and I lost all my fish. I would be very glad to get another supply.

253. *Statement of Felix McCurley*, 733 *West Baltimore street, Baltimore, Md., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—January 29, 1880, I received 19 carp, and November 4, 1880, I received 50 more, which I placed in a pond with a muddy bottom, covering perhaps 2 acres. My pond is situated on the Patapsco River, 5 miles from Baltimore. A small stream constantly flows through it into the Patapsco River.

PLANTS.—It contains grass, cat-tails, and calamus.

ENEMIES.—It also contains turtles, frogs, sun-fish, catfish, several other kinds of small fish, and musk-rats. Fish-hawks come to the pond and prey upon the fish.

FOOD.—I have not fed the carp or taken any trouble with them, and do not know whether they have spawned. I have never caught one, and it is impossible to tell how many I have.

254. *Statement of J. Randolph Mordecai, Baltimore, Baltimore Co., Md., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I put the carp which I received into a pond covering about $\frac{1}{4}$ of an acre, with a depth of from 2 to 3 feet and a bottom of mud.

PLANTS AND ENEMIES.—It contains various water-grasses and quite a number of frogs.

GROWTH AND REPRODUCTION.—The old carp are now about 18 inches long, and their young appear to be about 3 inches long.

MISCELLANEOUS.—This fish is admirably adapted to the uses of the farmer, easily and economically raised, and apparently free from disease.

255. *Statement of William Shirley, Baltimore, Baltimore Co., Md., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—About 3 years ago I got 20 carp, and have received some twice since. I have kept them in a pond about 45 by 90 feet, and about 3 feet deep. The bottom is muddy. It is supplied by 3 or 4 moderate-sized springs, and surface drainage, which in severe storms would fill a 12-inch pipe. The temperature of the water varies according to the season; it is now about 78°.

PLANTS.—There are a few water-lilies in the pond.

ENEMIES AND FOOD.—There are no other fish in it and no turtles, but there are a few frogs. I have caught many musk-rats, but do not know if they disturb the carp or not. I give them boiled corn once a week.

GROWTH.—They now weigh, on an average, 2 pounds; some are much larger. There are about 4 of the first lot left.

REPRODUCTION.—They have produced several hundred young, which are now of all sizes, from 2 inches up. We see a great many small ones swimming about when the water is clear. Some of them have washed over into an adjoining pond. I think that we have all the fish our pond can support.

256. *Statement of Michael Willax, Baltimore, Baltimore Co., Md., Aug.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—I first received carp some 3 years ago; they were 40 in number. Subsequently I received 125. The pond in which I have kept them is ¼ of an acre in size and from 4 to 8 feet deep. The upper part is sandy, the lower part muddy. I could not exactly state how much water flows through it, as it is fed by 3 or 4 springs. The water is not very cold.

PLANTS AND ENEMIES.—It contains any quantity of grasses and plants. There are also very nice shade trees about its upper portion. I have seen eels and green frogs in the pond.

FOOD.—I give the carp bread, corn-meal cakes, wheat, and rye. I feed them about twice a week.

GROWTH.—There are 38 left out of the first lot that I received. I could not state as to the others, as I have not drained the pond. They weigh from 5 to 8 pounds, and from 1½ to 3 pounds.

REPRODUCTION.—They hava produced thousands of young; the pond was literally lined with them last year. The young ones weigh from ½ pound to 1½ pounds. There are also smaller ones and young spawn in the pond.

257. *Statement of R. H. Woolen, Brooklandville, Baltimore Co., Md., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—About 2 years ago I received 12 carp and put them in a pond covering ¼ of an acre. About 2 days afterward a heavy rain washed both pond and carp away.

258. *Statement of E. A. Welch, Catonsville, Baltimore Co., Md., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received about 50 carp in April, I think, 1881. I have kept them in a small pond 20 yards square, with a sandy bottom, and only about 3 feet deep. A very small branch flows through it, which is dry usually from August to October.

PLANTS.—There are cat-tails, smart-weed, &c., in the pond. I intend to sow water-cress.

ENEMIES.—It contains no fish, but it contains bull-frogs, branch-frogs, and an occasional snapping-turtle. I have not fed the carp.

GROWTH.—I have about a dozen of the original lot left. They are about 14 inches long.

REPRODUCTION.—I have only found 20 or 30 young ones in all; but the pond has washed away twice. Those which I have found are about as large as my hand.

DIFFICULTIES.—My only difficulty has been the smallness of the pond, which I hope to remedy.

259. *Statement of M. Gillet Gill, Florence, Baltimore Co., Md., July* 21, 1883.

DISPOSITION OF CARP RECEIVED.—In 1880 I received 20 carp. I put them in a pond, with a muddy bottom, 20 feet square. The pond has an inflow of half a gallon per minute, and contains ordinary vegetation, but no other fish, frogs, or turtles.

FOOD.—I fed them with corn and occasional refuse from the table.

DIFFICULTIES.—They were washed out by a flood. When I have a more suitable place I will try it again.

260. *Statement of Charles J. Riddle, Forks, Baltimore Co., Md., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—November, 1879, I received 20 carp, and have since obtained 40 more. I have kept them in an ice pond from 2 to 4 feet deep, with a muddy bottom. A small stream of spring water flows through it, which is clear and good, except when it rains; then it overflows and muddies the pond.

PLANTS.—There are no plants nor grasses in the pond, and the stock eats the grass on the banks, so we have to feed the fish. I obtained some water-grass and planted it, but it did not live.

ENEMIES.—The pond had bull-frogs and turtles in it. We shot the latter, as we were afraid they would eat the fish. The frogs are still there.

FOOD.—We feed the carp irregularly with bread, corn, and sometimes cabbage.

GROWTH.—I have no old ones left. We ate them last spring, as we thought there were enough young ones to do well. They were then nearly 2 pounds in weight. What we have did not seem to grow last year as they did at first.

REPRODUCTION.—There are a goodly number of young ones, of various sizes.

MISCELLANEOUS.—My principal difficulty has been that they are hard to catch. We have to let the water out of the pond, and go in the mud and catch them by hand; as they do not bite the hook. We tried to catch them with a seine but failed.

261. *Statement of James Burton, Greenwood, Baltimore Co., Md., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—In February, 1881, I received 20 carp, but I had not finished my pond and so lost most of them. Afterwards I received 98. The pond is perfectly round, measures 80 feet across, and is 4 feet deep. The bottom is of clay, with sandy spots in it, and is fed by a strong running spring. The water is cold in the milk-house, but when it empties into the pond it gains heat and becomes much warmer than the streams. I want to make another pond to put the large carp in this fall. They are a splendid fish.

PLANTS.—Plantain and blue grass grow on the edges of the bank. The water is too deep for any grass to grow in it. There are no other fish but carp in it. We shoot all the frogs we find. No turtles can get there.

FOOD.—We boil potatoes for them, and give them stale bread and refuse from the table. We feed them every 3 or 4 days.

GROWTH AND REPRODUCTION.—I do not know how many of the original lot I have left, as the water is stirred up during the spawning season. I caught one last fall 14½ inches long and 8¼ inches around. Some of them grow faster than others. There are some young; they go in schools. The spawn of last season were from 3 to 4 inches long in the fall.

262. *Statement of W. H. Shirley, Harrisonville, Baltimore Co., Md., Aug.* 19, 1883.

DISPOSITION OF CARP RECEIVED.—I received 55 carp in November, 1880. I have kept them in a pond of running spring water, which is 70 feet long, 25 feet wide, and 4 feet deep, with a sandy and muddy bottom. Enough water flows through it to fill a 4-inch pipe. A part of the pond 50 feet long was made 5 years ago, and I have added 20 feet since.

ENEMIES.—It does not contain any other kind of fish, but it contains ordinary frogs.

FOOD.—We gave the carp corn and corn dough once a day.

GROWTH.—Last fall, when I lost them, there were some that would have weighed over a pound. I believe that I had over a hundred altogether then.

EDIBLE QUALITIES.—The next day we had some fried, and they were the nicest fish I ever tasted. I would not have taken $25 for the lot I had, for I prized them very highly. The carp is as fine a fish as I want to raise or eat.

DIFFICULTIES.—At the time of the Oriole last fall, while my wife and I were in Baltimore, the man whom I had employed to work on the enlargement of my pond, not knowing that the fish were in it, cut a ditch and turned all the water and carp out. He discovered some of them, and, being scared, brought them to the house, and then left before I got home, although if he had put them back in the pond he could have saved them.

263. *Statement of Andrew Reese, Lutherville, Baltimore Co., Md., July* 20, 1883.

DISPOSITION OF CARP RECEIVED.—About 3 years ago I received about 50 young carp 2 inches in length, and placed them in a pond of fresh water supplied from a spring and emptying into Roland Run. This pond is about 30 by 60 feet, with a shelving shore and a muddy bottom. Its greatest depth is 4 feet. It is about 11 miles from the city of Baltimore and about 3 miles above Lake Roland, which supplies Baltimore with water. It was early in the winter that I stocked the pond, it having previously been cleaned of all impurities. Unfortunately a heavy freshet broke down the embankment of the lower end of the pond and washed all the fish into Lake Roland. Again, a second time, after fixing the pond, as I thought, more securely, I stocked it with about 60 young scale carp, and they too went down the stream into the lake. If I had a suitable pond I would not part with my carp.

PLANTS AND ENEMIES.—The water was kept free from grasses, as it was an ice pond. There were no other fish, and no frogs, turtles, nor other reptiles in it.

FOOD.—I fed the carp once a week with water-crackers, and occasionally with worms.

GROWTH.—I was surprised to find that the first lot of fish, in 6 months after they had been planted in the pond, had grown to the length of 7 inches.

LAKE ROLAND STOCKED.—Lake Roland must by this time be pretty well stocked, as I have lately seen some fine specimens that were taken from it.

264. *Statement of Thomas V. Richardson, Phœnix, Baltimore Co., Md., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—In the autumn of 1880 I received 50 carp. I have kept them in a pond about 200 feet long and 35 feet wide, with an average depth of 3 feet and a muddy bottom. The pond is supplied with water from several springs situated from 50 to 200 yards distant, which yield about 3,000 or 4,000 gallons daily.

PLANTS AND ENEMIES.—There are no plants nor grasses in it, but there are some around the banks. No other fish and no turtles inhabit it, but it contains frogs.

FOOD.—I did not feed the carp any the first year, and never feed them in winter. In summer I give them corn-meal and scraps from the kitchen once a day.

GROWTH.—I cannot tell how many I have left of the original lot, as they keep the water always muddy, but I have seen half of them, at least. I caught 2 last spring, the larger of which measured 16 inches and weighed 2½ pounds.

REPRODUCTION.—I have seen quite a number of young ones, probably 200 or 300 at one time. They appear to be from 4 to 8 inches in length.

265. *Statement of T. J. Myer, Pikesville, Baltimore Co., Md., Aug.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—I received one dozen very small carp about 2 years ago. I put them into a pond about 200 feet long, 50 feet wide, and 5 feet deep, with a very muddy bottom. It is supplied by a small stream of water, which has a temperature of about 60°.

PLANTS AND ENEMIES.—It contains pond-lilies, and there are in it goldfish, silver-fish, sun-fish, frogs, and a few pond-turtles. I do not know that any carp are left. They are supp osed to have been destroyed by other fish.

266. *Statement of C. Trump, Rossville, Baltimore Co., Md., Nov.* 3, 1880.

GROWTH.—The 20 carp received last spring are doing well and have grown finely. From all appearances they must be 10 inches long.

267. *Statement of S. Van Trump, Shane, Baltimore Co., Md., Aug.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—In January, 1881, I received 20 carp. The pond in which I have kept them is 90 feet long, 30 feet wide, and from 3 to 4 feet deep, and has a muddy bottom. About 120 gallons per hour of spring water flow through it.

PLANTS.—Water-lilies and swamp-grass grow in the pond.

ENEMIES.—It contains sun-fish, minnows, bull-frogs, snapping-turtles, &c.

FOOD.—I give the carp bread and a little corn in grain once a day.

GROWTH AND REPRODUCTION.—I have 10 of the carp left, now weighing from 1½ to 3 pounds. They have not produced many young, if any at all.

268. *Statement of E. Herman, jr., Towson, Baltimore Co., Md., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 50 carp in December, 1880, and have kept them in a pond 50 by 150 feet, with a depth of 2 feet. The bottom is composed of very soft black mud or loam. About 20 barrels of water per day pass through it, about as cold as spring water generally is after running 300 yards from the spring. I intended to enlarge the pond in the fall.

PLANTS.—A few wild grasses and lilies grow in it, and there is plenty of grass around the edges.

ENEMIES.—It contains frogs and tadpoles in great numbers.

FOOD.—I don't feed the carp. They live on the grass around the pond and on tadpoles, and are fat.

GROWTH.—I have about 30 of the original carp left. They weigh from 7 to 8½ pounds each, and are from 20 to 24 inches long. The young ones are from 1 inch to 16 inches long.

REPRODUCTION.—There have been more than a thousand young produced.

MISCELLANEOUS.—I think the carp is the best fish for our ponds. I have tried other fish. The carp is the only one that does well.

269. *Statement of C. Bohn Slingluff, Towson, Baltimore Co., Md., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp first in 1881. There were 50 of them, I believe. In the autumn of 1882 I had 50 more. I have kept them in a pond covering about ⅛ of an acre, with a muddy bottom and a depth of from 18 inches to 6 feet. The water is supplied by surface drainage and by springs in the bottom of the pond.

PLANTS AND ENEMIES.—There are several grasses in the pond. I find bull-frogs spring-frogs, snapping-turtles, and another kind of turtle in it.

FOOD.—I have not fed the carp systematically.

DIFFICULTEIS.—The first lot was washed away by a flood. I have not seen the ones received in 1882 since they were put in. The water is generally discolored, and I have not let it out.

270. *Statement of J. W. Shemwell, Prince Frederick, Calvert Co., Md., Aug. 9*, 1883.

DISPOSITION OF CARP RECEIVED.—In March, 1881, I received 50 carp. I put them in an ice pond covering about 450 square yards, with an average depth of 2½ feet, with a maximum depth of 5 feet. Its bottom is composed of soft mud. One medium-sized spring supplies the pond.

PLANTS AND ENEMIES.—It contains swamp-collard (a kind of cabbage) and other water-grasses. It also contains minnows, frogs in abundance, and eels.

FOOD.—I give the carp corn-meal dough and all kinds of vegetables. I feed them irregularly; usually once or twice a week.

GROWTH.—They were 12 inches long last October. The 2 that I now have are, I suppose, about 15 inches in length.

REPRODUCTION.—There must have been several thousand small carp hatched in the spring of 1882. I caught one before the pond broke in the fall which was about 4 inches long.

DIFFICULTIES.—In October, 1882, we had the greatest fall of rain which has occurred in this section of the country for many years. It swept the banks of earth away at the deepest part of the pond and carried every fish in it into the Chesapeake Bay. I caught two of the large fish down the branch with a hand net. They were then 12 inches long. After I had had the pond repaired, I put them back in it, but have seen no young ones since.

271. *Statement of James E. Hignutt, Denton, Caroline Co., Md., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—May, 1881, I received 10 scale carp, and in December, 1881, 40 leather carp. November, 1882, I received 20 scale carp, and in March, 1883, 40 more. I kept them in a pond of 1½ acres. Most of the bottom is muddy. There is not a large flow of water, as I have turned the larger part of the surface water down the sides of the pond.

PLANTS AND ENEMIES.—The pond contains rushes and long marsh-grasses. There may be a few small pike and turtles in it, but not many.

FOOD.—I feed the carp on bread and cabbage, about twice a week.

GROWTH.—The 40 scale carp that I received March, 1883, are now from 4 to 7 inches long, and will weigh from 7 to 12 ounces.

DIFFICULTIES.—All of the three previous lots were lost by the breaking of the dam. I am satisfied that the dam should be made a year before the fish are planted.

272. *Statement of J. W. Kerr, Denton, Caroline Co., Md., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—About 2 years ago I received 40 carp. I kept them in a pond covering ¼ of an acre, with a muddy bottom, but lost them, within a short time after putting them in, by a heavy freshet, which broke the dam, and carried them all into the Choptank River. There is usually a very light flow of water. After heavy rains there is too much. The water is quite warm in summer.

PLANTS AND ENEMIES.—There are few plants in the pond except green frog-moss. It contains bull-frogs and some little minnows.

273. *Statement of I. R. M. Nash, Fowling Creek, Caroline Co., Md., April* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp December 18, 1882. The ice was fully ¼ of an inch thick in the kettle when I arrived home. It was broken up, and the fish appeared sore from their ride over the frozen ground. I cut through pond ice an inch in thickness and deposited the carp in the pond.

FOOD.—I have given the carp scalded meal once a week, but did not see the fish until about a week ago.

GROWTH.—This week I have seen as many as 7 or 8 at one time and found them to be as large again as when I placed them in the pond.

274. *Statement of Richard H. Comegys, Greensborough, Caroline Co., Md., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 52 carp in November, 1879, and 40 little ones in April last. My pond covers about an acre and a good constant stream of water flows through it.

PLANTS AND ENEMIES.—It contains wild oats, flag, and water-grass; there are frogs in it, but no other fish nor turtles.

FOOD.—I feed the carp occasionally on bread and vegetables.

GROWTH.—My dam was washed out during the last season (1882) and I lost all I then had. At the time of losing them I measured one of the old stock that was 18 inches in length and 5 inches broad. The young were about 6 inches long.

REPRODUCTION.—They produced thousands of young ones, which were lost when the dam broke.

MISCELLANEOUS.—I consider carp valuable, being easily raised by any one who can have a pond.

275. *Statement of W. H. Comegys, Greensborough, Caroline Co., Md., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp in November, 1880, and some since then. I have kept them in a pond made by damming up a running stream. It is irregular in shape, its extreme width being 30 feet. Its depth is 6 feet, and it has a muddy bottom. About 5 gallons of spring water per minute usually flow through it.

PLANTS AND ENEMIES.—It contains but little grass of any kind, and no other fish. There are some bull-frogs in it.

FOOD.—I feed the carp occasionally with bread.

GROWTH.—One year ago the dam was washed away and only 6 of the original lot were saved. They are now supposed to weigh as much as 8 pounds.

REPRODUCTION.—A great many young ones were washed out, varying in size up to 6 or 8 inches in length. There have been a number hatched this season from the 6 that were saved.

MISCELLANEOUS.—My experience and observation are of the most satisfactory character. They are hardy, rapid in growth, and prolific, making them not only desirable but valuable to those who have the advantage of a pond.

276. *Statement of William Arbaugh, Carrollton, Carroll Co., Md., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received 100 three years ago last winter. I kept them in a pond 40 feet long, 20 feet broad, and some 2 feet deep at the deepest point, with a somewhat clayey bottom. The water flowed into it through a 1½ inch auger-hole from a spring, and some came from a small stream. It was not very cold. I took out the fish in the spring of 1882, and ate the largest of them and gave some few away.

PLANTS.—The pond contained some of what we call "sour grass." It is not worth much for food for anything.

FOOD.—I fed the fish with thick milk, hominy-screenings, and some worms.

GROWTH.—I had about 30 left when I took them out and disposed of them. Some of them were about 12 inches long, and some 7 or 8 inches.

DIFFICULTIES.—I think the rest died on account of the want of water and the small size of the pond. If I had plenty of water and space for another pond I would like to raise them, as I think they would pay.

277. *Statement of G. W. Armacost, Finksburgh, Carroll Co., Md., Sept.* 6, 1883.

DIFFICULTIES.—I received 50 carp December, 1879. The following summer we had a heavy rain, and my pond broke, and let the carp into Beaver Run.

278. *Statement of S. P. Weaver, Frizellburgh, Carroll Co., Md., Aug.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—I received 100 carp in November, 1881. I have kept them in a pond 50 by 70 feet in dimension and from 2 to 4 feet in depth. The bottom is partly of very soft clay; there is some gravel at one end. Very little water flows through it at this time of the year. The temperature varies with the weather.

PLANTS AND ENEMIES.—Grasses of different kinds, and weeds, grow around the edge. There are no other fish in the pond, but there are a great many frogs in it and some terrapins.

FOOD.—I feed the carp with vegetables—scalded corn meal, boiled potatoes, &c.

GROWTH.—The old ones are from 12 to 15 inches long. I cannot tell how many are left, as I cannot draw off the water.

REPRODUCTION.—They have been very prolific. Some persons estimated the number of young last fall at several thousand. The latter are from 1 inch to 6 or more inches in length.

DISPOSITION OF YOUNG.—I have eaten a very few, and have stocked a neighbor's pond with 30.

279. *Statement of Frederick Zahn, Frizellburgh, Carroll Co., Md., Aug.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—In the fall of 1881 I got 60, and in the fall of 1882 about 40. I kept them in a pond 70 feet long, 10 feet wide, and from 1 to 3 feet deep, with a muddy bottom. About a 2-inch pipe full of cold spring water flows through it.

PLANTS AND ENEMIES.—Considerable wild grass grows all around and through the pond. There are no enemies except a few frogs.

FOOD.—I give the carp thick milk and bread nearly every day.

GROWTH.—I have about 37 of the first lot left. I caught some yesterday, and the largest measured 13 inches and weighed about $1\frac{1}{4}$ pounds.

REPRODUCTION.—They have had no young yet. I thought there was plenty of spawn on the water last spring, but I had no young fish.

280. *Statement of Lewis Barlow, Sykesville, Carroll Co., Md., Sept.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—May 18, 1880, I received 20 scale carp; October 22, 1880, 20 leather carp; and November 12, 1880, 50 scale carp. I have kept them in a pond 30 yards long, 13 yards wide, and 3 feet deep. The bottom is muddy and soft. The water is supplied by a spring, which is not strong enough to cause it to overflow.

ENEMIES.—It contains no plants or grasses, but plenty of bull-frogs. I caught two mud-turtles, which were playing havoc among the carp.

FOOD.—I give the fish boiled corn twice a week, and wheat-bread occasionally.

GROWTH.—As near as I can tell, there are about 30 of the old fish left. They are from $2\frac{1}{2}$ to 3 pounds in weight.

REPRODUCTION.—They have produced a great many young, which measure from 2 to 8 inches. I think that every one who could raise carp should do so.

281. *Statement of Abram E. Null, Union Bridge, Carroll Co., Md., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—In December, 1880, I received 50 carp. The pond in which I have kept them is 50 feet square and 3 feet deep, gradually diminishing in depth. It has a yellow-clay bottom, and is fed by a spring.

PLANTS AND ENEMIES.—Various pond-grasses grow in it. It also contains catfish, bull-frogs, spotted-turtles, and one snapping-turtle.

FOOD.—I feed the carp twice a week with shelled corn.

GROWTH.—I have about 20 of the original lot left. Of 2 recently caught, one weighed $1\frac{1}{2}$ and the other $1\frac{3}{4}$ pounds. The largest young ones weighed $\frac{1}{2}$ pound.

REPRODUCTION.—Quite a number of young have been produced; I don't know how many.

282. *Statement of James W. Ogle, Union Bridge, Carroll Co., Md., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 40 carp in 1879, and have kept them in a pond covering $\frac{1}{4}$ acre, with a depth of from 2 to 5 feet, and a muddy bottom. From 10 to 15 gallons of water flow through it per minute. The temperature is from 70° to 75°.

PLANTS.—I know of nothing growing in the pond but some meadow-grass and some weeds.

ENEMIES.—There are no other fish in it that I know of; but there are some water-terrapins and frogs. The terrapins eat the feed from the fish.

FOOD.—I feed the carp $\frac{1}{2}$ peck of corn mush each week, and all the vegetable refuse from the kitchen.

GROWTH.—I think I have still about 25 of the original lot. They would weigh from 3 to 5 pounds. The young ones are from 3 to 5 inches long.

REPRODUCTION.—By the looks of the young ones in the water there must be 2,000 of them.

283. *Statement of Solomon Shepherd, Union Bridge, Carroll Co., Md., Aug.* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received 250 carp in January, 1881. I have kept them in a pond 120 feet long and 30 feet wide, and from $1\frac{1}{2}$ to $3\frac{1}{2}$ feet deep, with a bottom of earth or mud. The water passes into the pond through a $1\frac{1}{2}$-inch pipe, but the flow does not always fill the pipe. It is discharged through a 2-inch pipe. There have been several weeks at a time when there was no water passing through the pond. The temperature of the water varies at different seasons, from 32° to 85°.

PLANTS AND ENEMIES.—It contains no plants or grasses and no other fish; one fall-fish lived with them for a time, but was caught with a hook and line a few days since, when he measured $8\frac{1}{2}$ inches. There are some frogs and turtles in it.

FOOD.—I have given them a little corn-mush and wheat-bread, but very irregularly, and not enough to facilitate their growth much. I expect to feed them more in the future than in the past.

GROWTH.—I lost most of my fish in June of last year. Some measured at that time 16 inches and some 12 inches. I do not know that I have any of the original carp left. A few days ago I caught 2, each of which was 16 inches long. I have come to

the conclusion that if they will grow to be 16 inches long in 8 months, as they have done in my pond, with so little care and feed, almost every person who has a spring or branch on his place, even though it be a weak one, can raise carp to advantage.

REPRODUCTION.—On the 21st of August, 1883, I let the water out of the pond and caught 2 old ones and 251 young. The latter were from 4½ inches to 9 inches long. There are now in the pond 239 carp.

EDIBLE QUALITIES.—We have eaten 12 of the young ones. They were fried, and the opinion was that their edible qualities are very good—first rate.

DIFFICULTIES.—In the early part of June, 1882, the banks of my fish-pond were washed away by a flood of water, and I think most of the fish escaped into the waters of Little Pike Creek. In 2 or 3 weeks from that time I caught 6 of the old carp, and subsequently, as noted above, found many young ones. I believe my pond has, also, been robbed of fish, and I think that that will be the principal difficulty in raising carp.

284. *Statement of Pemberton Wood, Union Bridge, Carroll Co., Md., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 250 carp in January, 1881. I have kept them in a pond 60 feet long and 25 feet wide and 3 feet deep, with a muddy bottom. I suppose from 15 to 20 gallons of water per minute flow through the pond. The spring just above the pond has a temperature of 54°.

PLANTS AND ENEMIES.—What we call swamp-grass grows on one edge of the pond. There are a few frogs in it.

FOOD.—I have not fed the carp since the first few months.

DIFFICULTIES.—I have not seen them this summer, and do not know whether they are still alive or have produced any young. My attempt at raising carp is a failure, owing, I believe, to the low temperature of the water.

285. *Statement of John T. Diffenbaugh, Westminster, Carroll Co., Md., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 50 in November, 1881, and have kept them in a pond covering about ¼ of an acre, about 3 feet deep, and muddy at the bottom. Water flows into it through a 2½-inch pipe. The temperature of the water varies with the weather.

PLANTS AND ENEMIES.—The pond contains no water-plants, nor grasses, nor other fish, but there are a few frogs in it.

FOOD.—I feed them with corn, screenings, and boiled potatoes, about once a week.

GROWTH.—I cannot tell how many I still have, as I have never taken them out of the pond. I suppose they are about 9 inches long, and would weigh about half a pound. I do not know that they have produced any young.

286. *Statement of Samuel Roop, Westminster, Carroll Co., Md., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1880, I received 250 carp, and in November, 1881, I received 200. I have kept them in 2 small ponds, with about ⅛ of an acre in each. They are about 3½ feet deep in the deepest places. Their bottoms were at first composed of gravel, but have become very muddy. About a 2-inch pipe full of water flows through them; it gets very warm in summer, especially in the lower pond.

PLANTS AND ENEMIES.—There are no water plants nor grasses in the ponds. I tried to grow some, but did not succeed. There are no other fish, but some few frogs.

FOOD.—I do not feed them much. About once a week in summer I give them boiled corn, or screenings, or potatoes.

GROWTH.—About 175 of the 1880 lot are still left. Last fall the largest weighed 1¼ pounds, and measured 15 inches. They grew much more the first summer than last summer. The second lot did not do so well. As I only draw off the water every fall, I cannot tell how the others are doing.

REPRODUCTION.—Last season I caught about 500 young ones, and I can see very many of this summer's hatching.

DISPOSITION OF YOUNG.—I have put some in the meadow brook, and have given some to neighbors.

287. *Statement of J. T. Wilhide, York Road, Carroll Co., Md., Oct.* 22, 1883.

DISPOSITION OF CARP RECEIVED.—I received 21 carp December 15, 1882, and put them in a spring pond until we could make a larger one. We lost all but one of them, which was put in the large pond last spring.

GROWTH.—To-day we drained it and found the carp a perfect beauty, weighing 1½ pounds, and measuring 12 inches in length. It is a scale carp.

288. *Statement of A. J. Michener, Colora, Cecil Co., Md., Aug.* 1, 1883.

DISTRIBUTION OF CARP RECEIVED.—November 11, 1880, I received 38 carp. I have kept them in a pond covering $\frac{1}{8}$ of an acre, and 5 feet deep in its deepest part. The bottom is quite loamy. The main water supply is from a cool and very strong spring situated some 300 or 400 yards distant.

PLANTS.—The pond contains the plants and grasses usually found in ponds.

ENEMIES.—It has no other fish in it that I know of, but it has a few small frogs and speckle-backed turtles.

FOOD.—I give the carp scraps from the kitchen, and those but seldom.

GROWTH.—I do not know how many of the original lot I have, but there appear to be several, although still quite small. The largest I have taken were 9 inches in length. I have only taken four.

REPRODUCTION.—I cannot say how many young they have produced, although there seem to be quite a number in the pond, ranging from $1\frac{1}{2}$ to 4 inches.

289. *Statement of A. W. Mitchell, Elkton, Cecil Co., Md., May* 30, 1882.

GROWTH.—A leather carp, weighing $2\frac{3}{16}$ pounds, and measuring 17 inches in length, was caught in a hauling-seine on Monday last at Crother's fishing-shore, at the mouth of the Susquehanna River. How it came in the waters of the northeast is a mystery, but it is supposed to have escaped from some pond. The fish was supposed to be about 2 years old.

290. *Statement of David Scott, Elkton, Cecil Co., Md., July* 21, 1883.

DISPOSITION OF CARP RECEIVED.—November 22, 1880, I received 40 very small carp. The weather was very cold. I kept them in the house several days until a few died. In November, 1881, I received 100. I have kept them in a pond covering $\frac{1}{16}$ of an acre, which I expect to enlarge this season to double the present size. Its depth ranges from 1 inch to 5 feet. The bottom consists mostly of mud. In the driest season there is always a stream flowing from the pond of perhaps 5 gallons per minute. On the 20th of July, when the mercury stood at 60° in the air, it marked 70° in the pond.

PLANTS.—There are several kinds of plants in it. The principal one resembles mint, and in some places covers a considerable part of the surface of the pond. The carp feed on its white roots, and hide under its foliage.

ENEMIES.—There are no other fish in the pond, but plenty of frogs. Last season there were a good many small turtles, most of which I shot. There is only one small one there now.

FOOD.—I feed the carp 2 or 3 times a week, or oftener, giving them bread, principally. Often I give them corn, potatoes, and other vegetables, usually boiled, but not in great quantities. All I ever see are in fine condition, eat their food eagerly, and shoot through the water like an arrow.

GROWTH.—I do not know how many of the first lot are left, for all were put into the same pond. Some may have got away by an overflow of the dam which occurred in 1881. I never weighed any of the carp, but they look, in the water, to be from 11 to 15 inches long, and quite broad for the length. They are over an inch between the eyes.

REPRODUCTION.—They have produced no young that I know of, but I am expecting an increase this season. I don't think they have been troubled with any disease.

DIFFICULTIES.—I have had no difficulty with the carp, except that the winter after I got the first 40 the melting of the snow caused an overflow of the dam, and probably some escaped. I have since surrounded my pond with a ditch, which will prevent another overflow. I regard carp culture as certain as that of poultry, or as stock-raising of any kind.

291. *Statement of F. S. Everist, Port Deposit, Cecil Co., Md., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received 50 carp in the spring of 1881, which I have kept in a pond of running water, about $\frac{1}{2}$ acre in size, and 5 feet deep, with a clay bottom. Considerable water passes through it, coming from 2 springs about 400 yards away.

PLANTS.—Plenty of grass grows near it which the fish feed upon.

ENEMIES.—I have some trout in the same stream; also frogs.

GROWTH.—I do not know how many of the original carp are still left or how many young they have produced, as I have not fished much for them. I caught 2 last summer, one weighing 1 pound and the other 2 pounds.

292. *Statement of Edwin H. Reynolds, Rising Sun, Cecil Co., Md., Aug.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—I received 150 carp in April, 1880. I have kept them in a pond covering a ¼ of an acre. The average depth of half the pond is 4 feet; of the balance, 18 inches. Its bottom is composed of heavy yellow clay, containing some iron; there is but little alluvial soil. The pond is fed by a spring, 300 yards distant, at the rate of 200 gallons per hour. The temperature of the water, at the surface, has been as high as 80°.

PLANTS.—It does not contain as many plants as I desire. I have transplanted into it the common lily, but this grows slowly.

ENEMIES.—There are no other fish in it, but many frogs. Turtles are scarce, as the life of one of them is at stake when its presence is known.

FOOD.—I have been feeding them daily, since April, with a peck of dough composed of two parts of corn meal and one part of wheat middlings stirred up in sour milk. The young now eat from my hand.

GROWTH.—I had 33 of the original lot this spring. In the first week of April they were from 16 to 18½ inches long, and weighed from 1½ to 2½ pounds. This year's spawning are from ½ inch to 3 inches in length. I regret to say that the pond, to my certain knowledge, has been netted twice by poachers, but I do not think that this can very well happen hereafter.

REPRODUCTION.—It is impossible to state how many young have been produced. A net 1 yard square can now dip up from 50 to 80, from ½ inch to 3 inches long, at any point around the pond.

DISPOSITION OF YOUNG.—I have placed 2,000 in Stone Run, distributed 250 in lots of from 20 to 40 free; and sold 380 at $5 per hundred.

DIFFICULTIES.—The most serious difficulty has been the depredations of the night-fishers and the turtles. So far, justice has been dealt to the former, and death to the latter, when they have been found out.

MISCELLANEOUS.—The introduction of carp fills a blank long felt in agricultural pursuits. I am fully convinced that their culture is not a mere fancy to be indulged in by the wealthy, but is within the reach of thousands of land-owners, in many places, who have land unfit for agricultural purposes, but which could, with little expense, be made to return a profit treble what could be made from grain or hay, by devoting it to the growth of carp. One can transform a bog-mire into a pond teeming with this valuable food-fish. I would not give up the product of the quarter-acre pond for that from any 2 acres of my farm, and I do raise 2½ tons of hay, 30 bushels of wheat, and 65 bushels of corn to the acre.

293. *Statement of S. L. Webster, East New Market, Dorchester Co., Md., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—In the spring of 1881 I received about 30 carp 3 inches long. I have kept them in a pond about 100 yards long, from 30 to 40 yards wide, and from 2 to 4 feet deep, with a muddy bottom. About 60 gallons of spring water per hour flow through the pond, ordinarily.

PLANTS.—It has rushes and other grasses such as are common on low lands.

ENEMIES.—There are catfish, sun-perch, and mullet, in it; also spring-frogs and common turtle.

FOOD.—At first we fed the carp on different kinds of bread, and refuse from the kitchen, but we have not paid much attention to them of late.

GROWTH.—I caught one this spring about 10 inches long. I suppose it would weigh 1½ pounds. I put it back in the pond, and have not seen it since. Until this one was caught, this spring, I had concluded that they had all gotten out during heavy rains when the water was running in a thick stream over the dam.

REPRODUCTION.—There are plenty of young fish in the pond. I do not know whether they are carp or not.

DIFFICULTIES.—The principal difficulty is that they keep near the bottom and stir up the water so that we do not see them often.

294. *Statement of R. R. Buckey, Johnsville, Frederick Co., Md., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 40 in 1880, and 100 in December, 1881. I have kept them in a pond covering ¼ of an acre, 4 feet deep, and having a soft, muddy bottom. The water is very cold and is supplied by 2 large springs.

PLANTS AND ENEMIES.—The bottom is clean; grass grows only along the banks. There are no frogs nor turtles in the pond; and no other fish except suckers. My most serious difficulty has been the destroying of the carp by geese.

FOOD.—I give the carp boiled corn and potatoes, twice a week.

GROWTH AND REPRODUCTION.—I am not able to say how many are left nor how many young they have produced. They are about 18 inches in length now, and 5 pounds in weight. I am well pleased with the German carp.

295. *Statement of George Souder, Lander, Frederick Co., Md., Aug.* 7, 1883.

DISPOSITION OF CARP RECEIVED.—I received 180 carp, November, 1880. I have kept them in a small pond of about ⅛ of an acre. The depth of the water is from 3 to 5 feet. The bottom is very muddy. Enough water flows through it, of the temperature of ordinary springs, to fill a 2-inch pipe.

PLANTS.—It does not contain much grass, nor plants of any kind.

ENEMIES.—There are no other fish in it, but plenty of frogs.

FOOD.—I have not fed them much.

GROWTH AND REPRODUCTION.—The old carp are from 10 to 18 inches long. I do not know how many there are, or how many young they have produced.

296. *Statement of J. W. Downey, M. D., New Market, Frederick Co., Md., July* 21, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in 1880, and put them in a natural pond, where there was formerly a limestone quarry, with an average of 4 feet of water, and a muddy bottom, with an average temperature in summer of about 50°.

ENEMIES.—It contains no plants nor grasses, but does contain catfish, frogs, and a few snappers and terrapins.

FOOD.—I feed the carp twice a week with corn-meal.

GROWTH.—The largest carp I have seen is 22 inches long. I did not weigh it.

REPRODUCTION.—I do not know how many of the original lot are left or how many young they have produced, but there are thousands.

HOW TO CATCH CARP.—I find carp will bite at a hook baited with the common earth-worm.

297. *Statement of William Downey, New Market, Frederick Co., Md., July* 21, 1883.

DISPOSITION OF CARP RECEIVED.—About four years ago I got 40 carp. The pond in which I keep them is about 100 feet square. It is a limestone quarry with several springs in it, and 5 feet deep. I have kept them on a muddy bottom.

PLANTS AND ENEMIES.—It contains plenty of grass. It is free from frogs, turtles, and other fish.

FOOD.—I give them boiled corn, bread, and scraps from the table.

REPRODUCTION.—I cannot tell the number of young that have been produced. The carp breed very fast. The pond is alive with them.

298. *Statement of B. Moffett, Point of Rocks, Frederick Co., Md., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—In the winter of 1880 I received 75 scale carp, which I have kept in a pond 40 by 130 feet, from 6 inches to 4 feet in depth, with a muddy bottom. A moderately cool stream of water about an inch in diameter passes through it continually.

PLANTS AND ENEMIES.—The pond has calamus and other grasses growing in it, and also suckers, bull-frogs, and sliders. I have never seen any turtles. My principal difficulty has been with blue cranes and muskrats.

FOOD.—I give the carp corn and corn-meal dough at rare intervals.

GROWTH.—The original carp weigh from 5 to 7 pounds and appear to be from 20 to 30 inches long. Their young are from 2 to 3 inches long.

REPRODUCTION.—Last May was the first time we ever saw any young carp. I do not know how many have been produced.

299. *Statement of William G. Wilson, Unionville, Frederick Co., Md., Aug.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—I received 48 carp in June, 1881. I have kept them in a triangular pond from 2½ to 4½ feet deep. The 2 longest sides measure 150 feet each, and the short side measures 75 feet. A constant stream of water coming from 7 springs, 800 yards away, enters the pond through a 2-inch pipe.

PLANTS AND ENEMIES.—The pond contains the grasses usually found on a farm. It has in it frogs, snakes, terrapins, goldfish, and salmon. The latter have been in it about three years, but never thrived. My principal difficulty has been from muskrats.

FOOD.—I feed the carp once a week with cabbage, bread, corn, cheese, offal of chickens, &c.

GROWTH.—I have about 15 left. Their weights must be from 6 to 12 pounds. I found a single scale to measure an inch and a half the longest way.

REPRODUCTION.—I cannot see any young yet. On Sunday, May 24, the carp were seen following each other in bunches of 3 and 4 around the edge of the pond, sometimes pushing each other out of water. I have never noticed anything like it since. I think they must have been mating.

300. *Statement of William N. Todd, Walkerville, Frederick Co., Md., Oct. 2, 1883.*

DISPOSITION OF CARP RECEIVED.—December 22, 1880, I received 20 carp for myself, and 20 for my step-son, M. C. Neidig. We put them all in his pond, which is 100 feet by 300 feet, from 3 to 4 feet deep, and has a muddy bottom. It is fed by spring water, the springs being ¼ of a mile distant. The outlet is into the Monocacy River.

PLANTS.—It contains calamus, wild celery, and other plants.

ENEMIES.—There are no enemies but frogs.

FOOD.—When they were young we fed them on boiled corn-meal.

GROWTH.—One caught a year ago weighed 3½ pounds.

STREAM STOCKED.—A tributary, Israel Creek, is a fine stream, from 20 to 60 feet wide and 5 or 6 feet deep, containing only mullet and sun-fish. I put 17 carp into this creek to stock it.

DIFFICULTIES.—Three that I put in a spring I fed, but they did not grow larger than sun-fish, and died when a year and a half old.

MISCELLANEOUS.—We do not get to the pond very often, and have never caught but 1. They must be very large by this time, but they may have got out in the Monocacy River.

301. *Statement of John S. Dallam, Bel Air, Harford Co., Md., Aug. 1883.*

DISPOSITION OF CARP RECEIVED.—I received 130 carp 3 years ago (May 7, 1880), and 20 leather carp last March. The pond in which I keep them covers nearly 1 acre, and is from 2 to 6 feet deep, and its bottom is composed of alluvial mud. It has a fine spring in it, and there is a continual flow of 2 or 3 square inches of water, sometimes increased by rains to 2 or 3 square feet.

PLANTS.—It has such plants and grasses as usually grow about springs or along small branches in this part of the country. We have tried to get wild rice to plant in our pond, but have not been able to procure it. I wrote to several seedsmen who advertise it, but they reported that they were just out.

ENEMIES.—There are water-terrapins, frogs, eels, and some small fish in the pond.

FOOD.—I give no food except occasionally when I cast into the pond a few pieces of bread to see the carp come up and fight for it.

GROWTH.—I caught some of my carp October 11, 1880, and found them to average 2 or more pounds and to measure over 15 inches in length. One of them weighed 2½ pounds. I do not know how many of the old ones are left now. The largest which I have taken out weighed 4½ pounds, and the longest one I have seen measured 21 inches. The young ones weigh from 1 ounce to 2½ pounds.

REPRODUCTION.—I do not know how many young have been produced, but I know I have 6 different sizes, and perhaps more.

DIFFICULTIES.—I have had no difficulty except to protect the surface water from overflowing the pond and washing out the young fish. We have now a wire sieve 6 feet square for the surface water to pass through, and it answers very well.

HOW TO CATCH CARP.—We catch the fish by baiting a hook with a piece of bread about ½ inch square and dropping it to the bottom of the pond. The fish swallow the bread and hook. We use no other bait. We have not caught any since last fall, except a few for amusement. None of the old ones have been taken out this season.

302. *Statement of Alexander M. Tulford, Bel Air, Harford Co., Md., July 23, 1883.*

DISPOSITION OF CARP RECEIVED.—I received about 100, probably in 1880. I placed them in a pond 2 acres in extent, a small part of which is 7 feet deep. A strong spring branch flows through it. The water is warm in the pond.

PLANTS.—It contains bushes and grass, but no plants naturally adapted to the water.

ENEMIES.—There are in it a few small fish and frogs, such as are generally found in this section; they are not of much account.

GROWTH.—Four months after the carp were put in the pond I found 2 of them to be each fully 8 inches long and large in proportion. Having at that time never seen a carp of any size, I could scarcely believe that they were carp that had grown so fast.

STREAMS STOCKED.—I placed those which were left in the branch; and Byrum's Run, to which it leads, should be well stocked by this time from those lost by my pond, though I have made no inquiry about the matter.

DIFFICULTIES.—The 2 which I measured then were all that I had left, as during a heavy rain, in consequence of the wires at the outflow opening being obstructed with trash, the water washed under the water-gate and all the rest got out. Some of them were saved and eaten by the farm hands before I knew anything of the circumstance. I have never fixed up my pond, knowing its liability to the same trouble.

MISCELLANEOUS.—I know of a pond near here where the carp have done well.

and are much liked. I consider your work a very important one for the farmers and the country, and I always advise my friends to build and stock fish-ponds. I would fix mine up if I had a more suitable place, and may do so anyway.

303. *Statement of R. Emory, M. D., Taylor, Harford Co., Md., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—In 1878 I received 5 carp; in 1879, 20; in 1880, 100; and in 1881, 100. I have kept them in a pond about 150 feet long, 75 feet broad, and 5 feet deep, with a bottom of soft mud formed by sediment. It is fed from a branch through a 5-inch pipe.

PLANTS.—It contains no plants except wild grass which usually grows along streams in this locality.

ENEMIES.—Suckers, bull-frogs, turtles, and terrapins abound and are a great detriment.

FOOD.—I feed them on boiled corn or corn-dough, at irregular intervals.

GROWTH.—The first 5 are still there, but only about 100 of those subsequently put in remain, although I have never seen a dead fish, or one in the least sick. They are about 16 inches long and about 3 pounds in weight.

REPRODUCTION.—They spawned one season, 1880, but I have seen no spawn since. I drew off the water this spring, but saw no fish of that age. I think the frogs and turtles eat up the young before they are old enough to get out of their way. I don't think my fish spawned at all this fall.

304. *Statement of Joseph Hayghe, Upper Cross Roads, Harford Co., Md., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—We received 20 carp about 3 years ago, and 40 subsequently. The pond in which they have been kept is 36 feet across in one direction and 33 in the other, and is 3½ feet deep at the deepest part. A stream of water about 1 inch in diameter passes through the pond; its temperature is from 75° to 85°.

PLANTS.—It contains the principal wild grasses; I cannot give the names. It has in it frogs, a few turtles, and a few eels, which we are trying to check.

FOOD AND GROWTH.—We do not feed them any, except at some chance times on wheat-bread. I suppose they are 12 or 15 inches long.

305. *Statement of James Harban, Dayton, Howard Co., Md., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received 19 carp May 7, 1880, and 50 more November 10. The pond in which I keep them was intended for ice. It covers about ¼ of an acre, and has a depth of from 3 to 4 feet. Its bottom is quite muddy. I have it so arranged that the supply can be controlled and the water kept at about the temperature of our common streams.

PLANTS.—Grasses and rushes grow around the margin and around a central island.

ENEMIES.—I have it so arranged as to prevent the ingress or egress of any fish. I have caught 2 snapping-turtles and lots of frogs.

FOOD.—I give them boiled corn, corn-bread, cabbage, potatoes, and, in fact, most scraps from the kitchen. I have been very remiss in feeding.

GROWTH AND REPRODUCTION.—I caught old carp last summer 17½ inches long, and one about the same size this spring, but suppose there must necessarily be some larger by this time. The pond seems to have a goodly number of fish of all sizes in it. I cannot tell how many have been produced, as I have no way of ascertaining. I have no seine, and they do not seem to take to the bait very well. I see quantities of them not more than an inch in length.

306. *Statement of J. D. McGuire, Ellicott City, Howard Co., Md., Aug.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—Three years ago I received 15 carp, and 2 years ago 100. The pond in which I put them is about 90 feet long, and has an average width of 30 feet. The bottom is composed of mud. There is 1 small spring in the pond, and several streamlets enter it from other springs.

PLANTS AND ENEMIES.—There are no water-plants in the pond, but common blue grass grows down to the water's edge. It has no fish except carp, but plenty of frogs and some snapping-turtles.

MISCELLANEOUS.—Since putting them in the pond I have never seen one, either dead or alive, although I have fished for them with worms.

307. *Statement of William A. Ridgely, Glenwood, Howard Co., Md., July* 26, 1883.

DISPOSITION OF CARP RECEIVED—I received 100 carp 2 years ago last April, 80 of which lived and were put into the pond. My pond is 20 by 50 yards in size and about 3 feet deep, and has a muddy bottom. It is supplied with water from several springs about 100 and 150 yards above it,

PLANTS AND ENEMIES.—It contains bulrushes and wild grass. There are no other fish in it, but there are a few frogs and small turtles.

FOOD.—I feed the carp with boiled potatoes about every 2 weeks. Have heard that boiled corn-meal is good for them.

GROWTH.—Nearly all of the original lot remain, last week being the first time I caught any, when I took 5. They weigh a pound and over.

REPRODUCTION.—The water is so muddy that I have not been able to see any young. I have been told that there are no young ones for 3 years.

308. *Statement of Benjamin G. Cissel, Highland, Howard Co., Md., July* 20, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1880, I received 50 scale carp about 2 inches in length. The pond in which I kept them is ½ of an acre in size and from 3 to 4 feet deep, with a northern exposure. The bottom is composed of fuller's earth. It is fed from a spring 20 yards distant. The volume of water flowing constantly would fill a ¾-inch pipe. The water in the pond is warm in summer and the balance of the year cold.

PLANTS.—Bulrushes, wire grass, red top, and timothy grass grow around the water's edge. There are none growing in the pond proper. The fish seem to feed mostly on the roots of red top.

ENEMIES.—There are no fish in the pond except the carp, but there are plenty of frogs and tadpoles, and I catch a turtle occasionally.

FOOD.—I give them corn-meal once a week. They are very fond of bread crumbs, especially those of corn-bread. Sometimes I also give them wheat-bran, which causes the young fish to feed at the surface in schools. The large size are fond of refuse from the kitchen—swill, with bonny-clabber.

GROWTH.—In April, 1882, I let the water out of the pond, and found 14 carp left, 12 inches long. They are now 12, 14, and 16 inches long. I don't think they are as large as they should be, owing to the want of aquatic plants, the coldness of the water, or faults in the construction of the pond. The young are from 1 inch to 7 inches long. Those that hatched out a year ago last May are 7 inches long, and are a very nice, sweet fish for eating. There are a great many 3, 4, and 5 inches long.

REPRODUCTION.—Last year my carp produced from 3,000 to 4,000 young. I can't see a great many of this year's hatching as yet.

DISPOSITION OF YOUNG.—Beside those which we have used for the table, I gave 30 of the second size to one of my neighbors.

MISCELLANEOUS.—I have had no difficulty in their care, but, on the other hand, they have furnished a delightful pastime for my leisure moments.

309. *Statement of Samuel Hopkins, Highland, Howard Co., Md., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—In the spring of 1880 I received 8 scale carp, and in 1882 I received 220 carp from Druid Hill, Baltimore. My pond covers one-fourth of an acre, has a muddy bottom, and is from 6 inches to 6 feet in depth. It is supplied with water from a spring and gets warm in summer.

PLANTS.—It contains grass and some aquatic plants, but no other fish, turtles, &c.

FOOD.—I have sometimes fed the carp on corn bread, but only seldom.

GROWTH.—Eighteen months ago 5 of the original ones averaged 5 pounds in weight and were 17 inches long. They did not breed any that summer; I do not know whether they have yet spawned.

MISCELLANEOUS.—I have disposed of none except a few to eat. They will be more appreciated as time goes on. The culture of fish in our State has undoubtedly been of great advantage.

310. *Statement of John T. Roston, West Friendship, Howard Co., Md., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1880, I received 50 young carp. The pond covers ⅛ of an acre and is now being extended to ¼ of an acre. Its depth is being increased from 2 to 4 feet. The bottom is partly mud and partly gravel and sand. An inch and a half stream of cold spring water flows into the pond. In the middle of the pond the water is warm, as it is situated in a very warm place.

PLANTS.—Some rushes, herd's-grass, and a variety of wild grasses which I do not know the names of grow along the banks of the pond.

ENEMIES.—There are no other fish, but there are plenty of frogs, some turtles, and some snakes.

FOOD.—I give the carp corn-bread, potatoes, and beans once a day. They are fond of corn-bread, and so are the tadpoles. The turtles like it very well.

GROWTH.—There were about 40 of the original carp left in February last, and I think there are that many yet. They are from 10 to 12 inches long, 3 to 4 inches wide, and 1½ to 2 inches thick.

REPRODUCTION.—About 100 young ones were produced last summer; but I don't know how many there are this summer, as I have not seen many yet. The largest of the young ones are 5 inches long and 2 inches wide. They have grown faster than the original lot did.

DIFFICULTIES.—My most serious difficulty has been that the frogs and turtles eat the food from the fish. I am of the opinion that the tadpoles eat the fish spawn in my pond. They devour a piece of bread or a potato by the time it touches the bottom.

MYSTERIOUS APPEARANCE OF GOLDFISH (?).—In my pond is a red fish, red as scarlet all over. Some say it is a goldfish. It is the same size and shape as the carp. When my carp were a year old I let the water out of the pond, and caught the fish one at a time by hand, and cleaned the pond out. There was no red fish in the pond then. Where did it come from? That is what puzzles me. There are no red fish about here, for if there were they could not get into my pond. It must be a carp turned red.

311. *Statement of John R. Brown, Woodstock, Howard Co., Md., Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—We received about 150 carp on the 9th of April, 1881. They have been kept in an ice pond 60 yards long, about 20 yards wide, and between 3½ and 4 feet deep. The water comes from a spring.

PLANTS AND ENEMIES.—It contains no water-plants, but has ordinary grass and weeds growing on its banks. No other fish were put in; a good many little minnows, however, have gotten into it.

FOOD.—Have fed them on boiled hominy, only a few times.

GROWTH AND REPRODUCTION.—I cannot tell how many of the original lot are left, or how many young they have produced, as they keep the pond muddy; although in winter we cut as clear ice as we ever did. We have only lost 2 that I know of. The largest caught measured 13 inches and weighed 20 ounces.

312. *Statement of George R. Parrott, Still Pond, Kent Co., Md., Aug.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—I received 10 carp in 1880 and 100 in 1881. I have kept them in an ice pond 1 acre in size and 5 feet deep in the deepest part. Its bottom is composed of sand and mud. It is fed by springs and rains.

PLANTS.—Rushes and flags grow in it. It also contains catfish, frogs, snakes, and turtles.

FOOD—I feed the carp with corn.

GROWTH AND REPRODUCTION.—I have caught some weighing 3 pounds. They are of all lengths, from 5 inches to 20 inches. How many there are I have not been able to tell, as the place they are in is just a common pond, made for ice in the first place.

313. *Statement of Samuel J. Hopkins, Colesville, Montgomery Co., Md., Aug.* 7, 1883.

DISPOSITION OF CARP RECEIVED.—I received 25 carp in May, 1880, and put them in a pond located by the side of a small branch. I sold the farm shortly afterward, and through neglect the stream washed the banks away, and the fish went out into the Northwest Branch.

314. *Statement of John Heeter, Hunting Hill, Montgomery Co., Md., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 big scale carp in January, 1882, and 20 more scale carp in 1883, from you. I have kept them in a pond 40 yards long and 50 wide, and from 3 to 4 feet deep, with a muddy bottom. It is supplied with water from 2 springs.

PLANTS AND ENEMIES.—It contains bulrushes and different varieties of weeds. It has the common water frogs in it, but no fish.

FOOD.—I give the carp bread from my table, soft corn, boiled potatoes, and turnips about twice a week.

GROWTH.—I think I have from 15 to 20 of the old carp left. They are from 18 to 20 inches long. The young ones are from 1 inch to 6 inches long.

REPRODUCTION.—I do not know how many young have been produced, but there seem to be great many.

315. *Statement of E. L. Tschiffely, Hunting Hill, Montgomery Co., Md., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1879, I received 18 carp. In 1880 I received 38 in good condition. I have kept them in a pond 55 yards long, 15 yards wide, and 4½ feet deep in the middle, tapering off to shallow water on the banks. Its bottom is composed of mud. A stream of cold spring water 1 inch in diameter

flows through it. Last fall I made an additional pond just below this one, the same size, and in all respects like it except that the water runs in from the first pond instead of directly from the spring. I put 1,200 in this pond in April.

PLANTS AND ENEMIES.—Grasses grow in small quantities around the edges of the pond, of which I do not know the names. There are no frogs nor turtles and no other fish.

FOOD.—I give the carp baked corn bread and boiled corn (shelled) 2 or 3 times a week.

GROWTH.—The old ones weighed from 2 to 3¼ pounds in April, 1883. I have 16 carp left of the original lot. (See under DIFFICULTY.)

REPRODUCTION.—I had about 3,000 young carp in April, which weighed from 2 to 3¼ pounds. The old ones have spawned since.

DISPOSITION OF YOUNG.—I have eaten about a dozen and gave 3 persons some to stock ponds with. I have also stocked another pond of my own.

DIFFICULTIES.—I have had no trouble with them, but have been disappointed in the slow growth they have made. I drained the new pond which I stocked last April, a few days ago, and was surprised to find the fish about the same size as when I put them in, although one of them had roe in it. The only objection I have to them is that they do not grow.

316. *Statement of Robert M. Mackall, Olney, Montgomery Co., Md., July 28, 1883.*

DISPOSITION OF CARP RECEIVED.—About the 1st of November, 1880, I received 50 carp. I have kept them in a pond that I made for ice, about ⅛ of an acre in extent and from 2 to 6 feet deep. One-third of the bottom is gravel; the balance clay. About 40 gallons of water per minute flow through it.

PLANTS AND ENEMIES.—Clover and timothy grow around the banks of the pond. There are no fish in it except carp, but there are a few frogs, and occasionally an eel gets in. Snakes also infest the vicinity. The only turtle which I have seen this year I shot. I think nearly all of the original lot were killed by negroes and turtles.

FOOD.—I give the carp boiled corn, potatoes, cabbage, and bread, feeding them once or twice a week.

GROWTH AND REPRODUCTION.—The old ones are now from 15 to 24 inches long and weigh from 2 to 4 pounds. The young ones are from ½ inch to 6 inches long. I drew the water from the pond last spring, and found 2 or 3 barrels of large fish in it, and many small ones. I did not eat any, as it was about spawning time.

DIFFICULTIES.—My pond is at some distance from my house and out of sight of it, so that parties can fish in it without much fear of detection. I believe it will pay any one to make a pond for carp if in sight of the house.

317. *Statement of Capt. John T. Fletchall, Poolesville, Montgomery Co., Md., July 28, 1883.*

DISPOSITION OF CARP RECEIVED.—I received 40 carp in November, 1880, and 23 leather carp in April, 1881. I have kept them in a pond about ¼ of an acre in size, with a depth ranging from 2 to 4 feet. The bottom is composed of loam mixed with clay. There is a spring at the head which supplies the pond. The water has a temperature of 70° in summer and freezes over in winter. The quantity of water I do not know.

PLANTS.—There are in the pond rushes, wild grass, and other growths usually found on marshy or low lands.

ENEMIES.—It contains quite a lot of water terrapins, which I destroy, and all kinds of water frogs. Have noticed 1 turtle.

FOOD.—I feed the carp with wheat, corn, bread, and sometimes scraps of vegetable parings. I have no regular time for feeding them; probably do so, on an average, once a week.

GROWTH AND REPRODUCTION.—I do not know how many of the original lot I have, as the water has never been drawn from the pond. The ones I caught last spring (1883) weighed from 1 to 2 pounds; I think, however, that I can see larger ones swimming about. I cannot tell how many young they have produced, but I can see different sizes when feeding them. I can see them ranging from, say, ½ an inch to 4 or 5 inches in length.

318. *Statement of William N. Young, Poolesville, Montgomery Co., Md., Sept. 28, 1883.*

GROWTH.—I thought that all of my carp were dead, until June 1, 1882, when I saw indications of them, and, on fishing with a net, raised out of the water 5 or 6 as broad as my hand.

REPRODUCTION.—The carp you sent me 3 years ago are doing well, and I have a fine lot of young.

319. *Statement of Benj. D. Palmer, Sandy Spring, Montgomery Co., Md., July* 21, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1880, I received 50 scale carp and 20 leather carp. The pond is supplied with spring water at an average rate of 6 gallons per minute. At noon of this date its temperature is 88° Fahr. at surface and 70° at the bottom. The area of the pond is $\frac{1}{6}$ of an acre, and its depth from 6 inches to 7 feet. The bottom is muddy.

PLANTS.—It has in it cat-tails and marsh lilies, also a border of marsh grasses.

ENEMIES.—There are no other fish, but there are plenty of frogs, and a few turtles recently arrived.

FOOD.—I feed the carp as often as convenient with bread and vegetable scraps from the table, boiled corn and wheat, and also wheat screenings.

GROWTH.—There ought to be 23 old carp left, as I have used 47 of the original 70. They are about 18 inches long, and from 2½ to 4 pounds in weight. Some may be larger than this. The leather carp are larger than the others. The young are from ½ inch to 9 inches in length.

REPRODUCTION.—Carp appear to spawn from May to October. Mine first spawned in the summer of 1882, at 2 years of age; and they spawned again this summer. They reproduced by thousands and thousands, so that the young fry are too thick to thrive; and I am giving the latter to all who will come for them. My pond has been eminently successful.

DISPOSITION OF YOUNG.—I have used 47 of the old ones, and find the scale variety first-rate eating. I have stocked my neighbors' ponds, and let the boys fish in mine. I have also put some of the young carp in the Northwest Branch.

DIFFICULTIES.—My principal difficulty has been to get rid of the excess of young.

320. *Statement of Edward Stabler, Sandy Spring, Montgomery Co., Md., Sept.* 26, 1882.

ENEMIES.—I found it difficult to get an ice pond to hold water, owing to the depredations of muskrats, honeycombing the banks. My last pond had to be lined inside with boards set on end and below the depth of the water, probably 100 or more yards around the pond. A few muskrats were caught in steel traps, but that did not abate the nuisance. We caught more feet than rats, for they would gnaw off the feet, leaving them in the trap, and escape. I subsequently destroyed them by the use of sulphur and saltpeter, finely pulverized, used together as an explosive.

There are three other drawbacks to fish-culture, but of easy remedy, namely: the turtle, the kingfisher, and the water-snake. For the destruction of these I use explosive shells of my own construction in a breech-loading rifle, but which are not safe to load in a muzzle-loader. They explode into fragments on striking, even on the water. These explosive shells are admirably adapted to the purpose of extermination for these pests, and also to destroy snakes in their dens. It is not safe to use solid balls, except in very isolated situations, as they glance on striking the water, and may go half a mile or more beyond. I know this is often the case in shooting deer while swimming, or other objects in the water. We have destroyed a score of turtles in this way. I am satisfied they feed on the spawn and very young fish. The kingfisher is an arrant poacher. A neighbor tells me that he has killed from 10 to 12 at his pond, and that they were stuffed with young carp.

FOOD.—My carp were occasionally fed in the past two months, some three or four times a week, on scraps of wheat and corn-bread, soft corn, boiled potatoes, fruit parings, &c.,

GROWTH.—I received my carp 2 years ago last April. They are now about the size of herring, from 9 to 10 inches long. I caught 1 recently which measured fully 17 inches in length, 5 inches in width, and 2½ inches across the back, and weighed 3 pounds. This carp is as large as the ordinary shad, and yet not 2½ years old from the spawn. The rapid growth of carp is wonderful, far exceeding either trout or bass. They are strict vegetarians, and rarely, if at all, feed on animal food. They never feed on their own fry, as the bass does indiscriminately on other small fish. There are well authenticated accounts of carp in European ponds, covering from 10 to 2,000 acres, living to a great age and attaining a weight of from 60 to 80 pounds, and raised for market like other products of the farm.

HOW TO CATCH CARP.—With the proper kind of bait, and in the hands of an expert, carp is readily taken, and is as gamy a fish as I ever caught with fly or bait. I recently caught one, a fair sample of the lot, with a barbless hook.

MISCELLANEOUS.—That carp will pay well without labor or capital expended, I am fully satisfied. Any one who has an ice pond may in 2 or 3 years have an abundant supply of fresh fish for the table, not to speak of the good sport which they may enjoy. The carp appears to be exactly suited to our ice ponds, where the water becomes very warm in summer and where in winter they can seek protection by hibernating in the mud at the bottom.

321. *Statement of Edward Stabler, Sandy Springs, Montgomery Co., Md., June* 30, 1883.

DISPOSITION OF CARP RECEIVED.—My pond contains some ¾ of an acre. The supply of water passes through a 4-inch pipe, which near the outlet or draining trough connects with a perpendicular iron pipe, at the top of which the water is discharged. During floods the water is conducted around the pond. The pond is lined with boards for 100 yards or more, making it proof against rats and craw-fish. The carp weighed from ½ to ¾ of a pound when they were received, April 1, 1882.

ENEMIES.—I now have plenty of sport shooting, in cutting off turtles' heads with explosive shells. I have killed several dozen in this way, and some very large ones, say 12 inches in diameter. I learned from an acquaintance, who has some large carp, that in draining his pond he found the tails of some of his large fish bitten off, no doubt by large turtles, which were seen there. On account of my frequent shooting at the pond, the remaining turtles have become almost as wild as wild turkeys, scarcely showing more than the nose above the water, and for a moment only; but it is enough if I can see the head a few seconds, as the shell explodes on striking the water, kills them, and in about 36 hours they float on the surface and can be taken out.

I was much surprised recently when, in setting a hook with meat-bait to catch the turtles—they are frequently taken in this way—I caught several eels of about 2 or more feet in length. They could only have entered through the ingress pipe 3 or four years ago, when of a finger's length, and through wire gauze having a ¼ inch mesh. They have grown almost as rapidly as the carp. As soon as my fish have done spawning I will let off the water and clean out turtles, eels, snakes, and all. Now that I have the fish and am keeping them so successfully, I do not intend that depredators shall have the benefit.

FOOD.—I fed them pretty regularly last summer, and they now come up of themselves to be fed.

GROWTH.—Last September I took 3 or 4, weighing quite 3 pounds apiece, which I returned to the water; and a few days ago, June 28, 1883, I took out a 5-pounder, but did not kill this one either. It was 20 inches long and 8 inches broad, and appeared to have from a gill to ½ pint of spawn in it. I have seen no young fish as yet.

322. *Statement of Asa M. Stabler, Spencerville, Montgomery Co., Md., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—I received 50 in April, 1882. The pond in which I have kept them is about 50 by 120 feet in size, and would average 2½ feet deep. It has a hard clay bottom. The water comes, at the rate of about 2 gallons a minute, from a marsh which abounds with springs. The temperature of the water is about 40° at this season of the year.

PLANTS AND ENEMIES.—The pond contains no other fish, and very little vegetation.

FOOD.—I give the carp bread occasionally. They have been neglected, in consequence of the pond being too far from the house.

GROWTH.—I suppose that there are 30 or 40 of the original lot left. They are about 12 inches long.

DIFFICULTIES.—I think that the hard clay bottom and the scarcity of water plants have been the greatest difficulty. I expect to make a more suitable pond, and would like to get young carp to stock it.

323. *Statement of Robert M. Stabler, Spencerville, Montgomery Co., Md., Aug.* 11, 1883.

DISPOSITION OF CARP RECEIVED.—I received 50 carp about 2½ years since. I have kept them in a pond about 60 by 70 feet large, with a depth of from 4 inches to 2½ feet. The bottom is composed mostly of mud. Water flows into it from two good springs 200 yards distant.

PLANTS.—There is no vegetation in it except the grass which is common in wet ground.

ENEMIES.—It contains no other fish. One turtle has been killed, and also several water-snakes.

FOOD.—I give the carp bread and corn, but not as often as they should have it, owing to the pond being so far from the house.

GROWTH.—I think I now have about 30 of the original lot. They are very small—will not weigh over one-half a pound.

REPRODUCTION.—I have not seen any young ones in my pond. My brother's pond, which is close by, and which contains carp of the same age as mine, has a great many young in it.

DIFFICULTIES.—My principal difficulty has been the great distance which the pond is from the house. I do not think the raising of carp will amount to much about here, unless we have good large ponds near the house so that they may be properly attended to.

324. *Statement of Admiral D. Ammen, Beltsville, Prince George's Co., Md., Nov.* 15, 1883.

DISPOSITION OF CARP RECEIVED.—On July 12, 1880, I received 53 carp. Four of the carp averaged 2 pounds in weight, 15 measured 4 inches in length, and 34 measured 1 inch in length. The carp are kept in 3 ponds. The surface of the first pond covers 10,500 square feet, the second 2,500 square feet, and the third 12,000 square feet. A 5-inch pipe supplies the ponds with water, the average flow of which is probably that of a 4-inch pipe at the rate of 3 miles per hour. The water is taken from a stream and has the temperature of the atmosphere. The ponds vary in depth from 6 inches to 4½ feet, and have soft, muddy bottoms.

PLANTS.—Japanese water-lilies grow in the pond.

ENEMIES.—The ponds contain eels, suckers, small turtles, bull-frogs, and probably minks and otters. The bull-frogs are not numerous. Snapping-turtles are occasionally seen. Eight large and many small eels have been killed. No doubt many eels remain in that part of the upper pond which is covered with only 6 inches of water. As the pond has not overflown, the sunfish and sucker spawn, found in the ponds, must have entered through a trap wire-cloth, one-sixteenth-inch screen. Muskrats bore holes in the banks of the ponds. These holes are probably occupied by minks. Within two miles of my ponds there is a stream, known as "Beaver Dam," having an extensive border swamp, a resort of otters, which probably breed there. Three of my breeding carp have been destroyed by minks or otters. From the size of the fish that have been destroyed, it is not improbable that otters have come up the stream to my ponds. Eels get into the ponds either through the wire screen or through the discharge pipes of the surplus water.

FOOD.—The first year I fed the carp on bread, corn-meal, and mush.

GROWTH.—In the upper pond only 2 carp were found where 10 were put 2 years ago. Of the 4 which weighed 2 pounds I have 3. I have 10 or more of the 4-inch carp. On November 10, 1883, the largest carp weighed 6 pounds and 5 others averaged 4½ pounds.

REPRODUCTION.—The young are in the pond by the thousand. I am unable to state the exact number, as I could not draw off all the water from the upper pond. About 90 carp averaged 1½ pounds, while 30 others averaged ½ pound. The young spawned in July, 1880, and approximate in size all of the original lot, except the 4 two-pound carp.

DISPOSITION OF YOUNG.—To the Christian Brothers, living near me, I gave 31 young carp, weighing from ¾ to 1½ pounds, and to a gentleman in Virginia I gave 12.

EDIBLE QUALITIES.—We have eaten leather carp boiled and fried. The larger carp I consider a fair table dish. Small ones are indifferent.

325. *Statement of J. E. Bailey, Centreville, Queen Anne Co., Md., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—In December, 1881, I received 40 leather carp. My pond is about ½ of an acre, with a bed of black sandy loam. It is fed by several springs, the water of which is of a medium temperature, but the situation of the pond is warm. The carp were in a sickly condition when received, and did not live.

GROWTH.—I have a friend, Mr. R. Holiday, whose fish are doing finely and are making rapid growth.

326. *Statement of J. M. Collins, Centreville, Queen Anne Co., Md., Sept.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—Soon after I placed in my pond the fish which I received the dam broke, and they were all lost. I intend to try again if I can get the dam to stand.

327. *Statement of Samuel T. Earle, Centreville, Queen Anne Co., Md., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 common scale carp in 1879, and 20 more in November, 1880. Last November I got from a neighbor 15 leather carp and 85 scale carp. I now have some in a mill pond and 2 other ponds.

The first lot were put into a couple of mill ponds with muddy bottoms, each about half a mile long and about 200 yards wide, one above the other. Both dams broke last September, but carp were afterward seen in the race of the lower mill, and the millers tell me that the lower pond is now full of them. The mill pond is 4 miles from me, and I have never seen the carp in it myself.

The 20 received in 1880 I put in a large covered spring, with a small embankment in front, say 4 by 10 feet of water, so that they could come out and return at pleasure, intending to remove them to a pond the following summer. The water was very cold but did not freeze when the thermometer marked zero. They were all alive the next spring, and I fed them up to June, when I could see but 3 or 4, which had

made not a particle of growth, or but very little. I then abandoned them as a failure. The little dam washed away, leaving them in this covered spring, overhung with shade trees. Last fall I put up a tenant's house near by, and the carpenter's little son discovered 23 fish in the spring, large and small. There was apparently nothing in the spring (it being very pure water) for them to feed on, and they were there without food for at least 18 months. I speak of this to show how hardy they must be. I transferred the 23 to a pond, where 22 of them still are.

The hundred fish which I obtained from Mr. Hollyday last fall I put into a small pond about 3 feet deep. I have lost but one of them that I know of. I saw about 50 of them at one time last April, and have never seen one since, although I am satisfied they are there.

PLANTS.—The mill ponds contain lilies and common water grass. One of my own ponds—the one with 22 carp in it—has a heavy growth of grass, etc.

ENEMIES.—The mill ponds have a few pike in them, and a great many black catfish; also common snapping-turtles and small red-bellied terrapins.

FOOD.—The carp in the mill ponds and my grassy pond are not fed. I feed those in my other pond with hominy, corn meal, dough, and wheat.

GROWTH AND REPRODUCTION.—Three or four of the 23 fish found in the spring last fall were 4 inches long. These were the survivors of the 1880 lot. The remaining 19 or 20 were young produced by them, and were about an inch long. The carp in the mill pond have, from all accounts, produced a great many young.

HARDIHOOD.—In November, 1880, I obtained 20 carp for Dr. Finley, who lives near Church Hill, in our county. He put them into a pond in his field which it is impossible to run off, but which very rarely dries up. In the summer of 1881 it became very low, and the cattle standing in it every day kept it so stirred up that one would have expected any kind of fish but catfish to have died. When at its lowest he dragged an old net through it and caught 15 carp in the one haul, with an average length of about 15 inches. Several of these were eaten by himself and neighbors and pronounced very excellent fish.

I heard of an instance in Harford County, Maryland, where a man's dam gave way and let out all the water from his pond, in which he had put carp some time before, except what was held by a small hole in its bed. The next summer he let off this water with the view of repairing and restocking pond, when, to his astonishment, the old stock was there, in good health. [See another instance above.]

CARP IN SALT WATER.—I heard of a scale carp which got out of Thomas Hughlett's pond on Miles River, in Talbot County, Maryland, and was caught in the stream at Pott's Mill, head of Miles River, and weighed 8 pounds. Miles River is salt water. This shows that they will live and thrive in salt water as well as fresh, although I feel sure they will make for fresh water, since this fish was caught at a place where the water is but little brackish..

328. *Statement of Richard Hollyday, Centreville, Queen Anne Co., Md., Oct. 20, 1883.*

DISPOSITION OF CARP RECEIVED.—I received 80 scale carp in 1879 and 40 leather carp in November, 1880. I keep them in 2 separate ponds of about $\frac{1}{2}$ of an acre each. The water is 5 feet deep, but shallow at the edges. It contains from 1 to $1\frac{1}{2}$ feet of mud in the center, and has sandy shores. It is supplied by a small stream from never-failing springs. There is but little waste except after a freshet. It is of medium temperature.

PLANTS.—The scale carp pond contains two varieties of pond lily. The other has a common flag or cat-tail.

ENEMIES.—They contain a few sun-fish, bull-frogs in great numbers, a few snapping-turtles, and numerous snakes.

FOOD.—I have fed them but seldom this season, sometimes giving them pure clabber, of which they are very fond; but I usually feed them with kitchen refuse.

GROWTH.—I think I can account for every one of those received. I let Commissioner Hughlett have 32 of the scale carp in 1881. I find that the leather carp grow much more rapidly than the others. I sold a pair to a neighbor in April, 1882, measuring 15 inches and weighing $3\frac{1}{2}$ pounds. He told me, not long since, that one of them measured 22 inches and weighed 8 pounds in July last. My leather carp have outgrown the other kind, though one year younger. I am inclined to the belief that the water being warmer in that pond suits them better.

REPRODUCTION.—They produced about 3,000 scale carp and 300 leather carp last year. I cannot yet estimate the number for this year.

DISPOSITION OF YOUNG.—I let Commissioner Hughlett have 2,500 and have sold 400 to neighbors.

EDIBLE QUALITIES.—Those that I have eaten I had corned over night and broiled for breakfast. I have invited a number of persons to eat them and all pronounce them delicious.

DIFFICULTIES.—The most serious difficulty has been the depredations by snakes and fish-hawks. I killed a snake this spring with 3 fish 14 inches long in it.

MISCELLANEOUS.—Mr. S. T. Earle has 20 scale carp that he kept in a large covered spring and that have not grown 1 inch in 3 years.

329. *Statement of John McFadden, Sudlersville, Queen Anne Co., Md., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received 40 carp in December, 1880, and 35 in 1881. I put them into a pond 20 feet square and 2 feet deep, with a muddy bottom. A very good stream of spring water flows through it regularly. Last year a freshet carried away all the old carp, but thousands of young ones are left, which I intend to move into a large, natural pond, about 100 yards long by 20 wide, where I cannot lose them by freshets, as it has no inlet, and will be fed only by springs.

PLANTS.—It contains water-lilies and all grasses that grow in low lands.

ENEMIES.—There are catfish, frogs, and turtles in it.

FOOD.—I feed the carp about once a week with a gallon or more at a time of ship-feed or middlings. I find it the best food I can give them.

GROWTH AND REPRODUCTION.—I presume that 10,000 young were produced by my original fish. They are from 1 inch to 10 inches long.

330. *Statement of W. H. Neal, Sudlersville, Queen Anne Co., Md., July* 21, 1883.

DISPOSITION OF CARP RECEIVED.—I received about 40 carp in December, 1880, which I lost by a break in my dam. I received about 40 more in the autumn or winter of 1881, and placed them in a pond of ½ of an acre, with a muddy bottom and a depth of from 1 to 4 feet. I cut a ditch around the pond to prevent overflow, and arranged a set of gates to hold water when needed; but the ponds are supplied largely by rain-water, and the temperature is moderately warm.

ENEMIES.—The pond contains catfish, eels, sun-fish, a few small pike, and some terrapins, known as red-bellies.

FOOD.—I am sure I can grow carp in this pond without regularly feeding them, and I think without ever feeding them at all. I have thus far fed them irregularly on scalded meal, scalded corn, corn and bran and meal uncooked, corn-bread, wheat-bread, and a little wheat-bread with soda in it.

GROWTH.—I have probably 1 or 2 dozen of the lot left, but no young. They are from 10 to 15 inches long. I am fully satisfied with my success thus far.

DIFFICULTIES.—I name the soda especially, because soon after giving them that kind of bread, but nothing else unusual, my carp, together with the catfish, eels, and sun-fish, sickened, and many of them died. My pond was a miniature Dead Sea for about a week. The rains came, however, renewing the water, and restored the appearance of life. The few fish I have left are healthy and apparently all right. Is soda a fish poison? My greatest difficulty was to make the dams secure, so as to hold the needed quantity of water and discharge the surplus without losing the fish.

331. *Statement of F. I. Wiley, Charlotte Hall, St. Mary's Co., Md., Sept.* 11, 1883.

DISPOSITION OF CARP RECEIVED.—I received 150 carp 2 years ago. The pond in which they have been kept is ¾ of a mile long, 300 yards wide, and from 3 to 20 feet deep. Its bottom is composed half of mud and half of gravel and sand. Enough water flows through it to turn a mill; it is fed by springs, and is never very warm, about 50°.

PLANTS.—Yellow lilies, reeds, and wild rice grow in the pond, and I have never given the carp any other food.

ENEMIES.—It is infested with catfish, sun-fish, yellow perch, frogs, and snakes.

GROWTH.—I have no means of telling how many carp there now are, as the water is too deep. I have only caught a few; these weighed from 1 to 1½ pounds. I cannot find any bait which they are very fond of.

REPRODUCTION.—I do not know how many young they have produced. I have caught a few, say 6 or 7, about 4 inches long.

332. *Statement of Levin L. Waters, Princess Anne, Somerset Co., Md., July* 21, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1881, I received about 40 scale carp, which I turned loose in the headwaters of the Manokin River, and have never seen nor heard of them since.

333. *Statement of Thomas Hughlett, Easton, Talbot Co., Md., Jan.*, 1882.

GROWTH AND REPRODUCTION.—In December, 1880, I deposited some leather carp in my pond near Easton. In February, 1881, this pond broke during a freshet, and some of the carp escaped to Miles River. In the following September some of them were

caught in a seine, and it was found that they hatched last year and some had grown to be 14 and others 19 inches in length, and weighed from 1½ to 2 pounds. The fish deposited in the pond in 1879 spawned this year, and from the 35 placed therein I took out this fall more than 1,000 young, measuring from 2 to 6 inches in length.

DISPOSITION OF YOUNG.—I distributed the 1,000 young to applicants.

HOW TO CATCH CARP.—Some of the carp that measured from 14 to 19 inches in length caught with a hook and line.

334. *Statement of Thomas Hughlett, Easton, Talbot Co., Md., Jan.*, 1883.

GROWTH.—The growth of carp is even more remarkable than was at first supposed. A few days ago Dr. Geo. R. Dennis drew off his pond in which he placed some carp just one year ago and found that 6 averaged a little more than 3 pounds each. About a month ago a carp was caught which escaped from the pond of Dr. I. L. Adkins, and which was placed there 2 years ago, that carried the scales down at 6 pounds, although it was not more than an inch long when deposited in the pond. Numberless cases could be cited in which the growth has been from 12 to 15 inches in a year, and the weight from comparatively nothing to 3 pounds in the same length of time.

REPRODUCTION.—I had 5 ponds constructed which cover about 3 acres of land. These ponds have actually produced 12,000 carp, and I have no hesitation in saying that but for the heavy freshets in September, which overflowed the ponds, the number would have been not less than 20,000. This is the second year that these fish have spawned.

EDIBLE QUALITIES.—Many carp have been caught near Easton and eaten by the citizens of that community, and in every instance the carp was pronounced a fine food-fish.

MISCELLANEOUS.—Not only has it been satisfactorily shown that carp will not only thrive in our rivers, but that its growth is even more rapid than in ponds, but it has been demonstrated that it thrives in salt as well as fresh water. On comparison, I find the carp caught in Miles River to exceed in size that attained in the same length of time in ponds.

335. *Statement of Thomas Hughlett, Easton, Talbot Co., Md., Aug.* 7, 1883.

DISPOSITION OF CARP RECEIVED.—There were 18 carp in the first shipment sent to me, and there have been others since. I have kept my carp in still ponds varying in size from ⅛ to ½ of an acre and from 6 inches to 12 feet in depth, with bottoms composed of mud or black loam. The temperature of the water varies from 20° to 80° Fahr.

PLANTS.—The ponds contain water-lilies, water-cress, &c.

ENEMIES.—There are some spring frogs in them. My principal difficulty has been to protect the fish from frogs, snakes, kingfishers, and fish-hawks.

FOOD.—In winter I feed the carp once a week, and from April to December once a day. I give them meal, clabber, potatoes, cabbage, boiled wheat, blood, &c.

GROWTH.—I have 85 old ones, which now weigh from 1½ to 8 pounds, and are from 1 to 2 feet long. The young weigh from 1 to 16 ounces and measure from 1½ inches to 1 foot.

REPRODUCTION.—About 35,000 young have been produced.

DISPOSITION OF YOUNG.—I have distributed most of them in ponds and rivers throughout Maryland.

CARP IN STREAMS AND SALT WATER.—I would recommend general distribution. I have discovered from the breakings of my pond that carp thrive quite as well in salt water as in fresh. Their growth is more rapid in our streams than in ponds.

336. *Statement of James T. Bartlett, Trappe, Talbot Co., Md., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—On November 8, 1879, I received 16 carp, from 1½ to 2 inches long. I placed them in a pond covering 2 acres, with 8 feet as its greatest depth, and a bottom composed mostly of gravel, but having plenty of mud in the deepest part. It never dries up; it is fed by a fine stream of spring water, which runs over a space of 7 feet, about 1 inch deep, nearly all the year. We put some brook trout in the pond, but have never seen any of them. I believe it is not suited to them, but think it is to the carp.

PLANTS.—It contains pond-lilies, and, where the depth does not exceed 3 or 4 feet, a kind of long grass grows from the bottom and floats on the surface.

ENEMIES.—Bull-frogs and skilipot, or yellow-bellied turtles, live in it; also catfish, pickerel, mullet, and many other fresh-water fish.

GROWTH AND REPRODUCTION.—In the spring of 1882 we set a net to catch other fish, and caught 6 of the scale carp from 8 to 10 inches long. Two of them were

injured, so we cooked and ate them and found them very good. The 4 we let go again. They were full of spawn.

STREAMS STOCKED.—In September, 1882, our dam was washed out and we lost all our fish. We found many young in the stream after the washing away of the dam. The stream from our pond runs into the Great Choptank, about 2 miles distant.

337. *Statement of W. W. Tunis & Bro., Tunis' Mills, Talbot Co., Md., July* 31, 1883.

DISPOSITION OF CARP RECEIVED.—We received 80 carp in the fall of 1881, and 100 more in the fall of 1882, 60 of which we let go in the river. We have kept the others in a pond which covers $\frac{1}{4}$ of an acre, is 2 feet deep in the middle, and has a very soft bottom. A small amount of spring water flows through it, and, in heavy rains, a large amount of rain water.

PLANTS.—Various plants and weeds, such as grow in this section, are found in the pond.

ENEMIES.—There are no other fish in it. The carp have driven out the frogs, we presume by eating the eggs.

FOOD.—We give them no food whatever. We think they eat the eggs or young. They bite at worms for bait.

GROWTH AND REPRODUCTION.—The first lot are now from 15 to 18 inches long; those put in last fall are from 8 to 10 inches. There were 37 of the original ones last fall. We have not seen them since except as they jump out of the water. We don't think they have grown much. They produced no young last year. We have not examined this year, but we do not believe they will have any young ones, as we do not feed them or give them any care.

HOW TO CATCH CARP.—Yesterday our boys caught 3 with hooks, in a few minutes, 9 inches long. They could have caught more, as the fish were biting fast.

338. *Statement of John R. Hopkins, Wye Mills, Talbot Co., Md., Aug.* 11, 1883.

DISPOSITION OF CARP RECEIVED.—About a year ago 18 carp were put into our mill-pond, but since then the dam broke. The pond is over a mile long and from 100 to 200 yards wide, with a sandy and muddy bottom. Enough water flows through it to drive a large grist-mill. The temperature varies with the season.

PLANTS.—There are plenty of all kinds of grasses around its shores.

ENEMIES.—The pond contained catfish, bull-frogs, snapping-turtles, and terrapin, all of which were lost when our dam broke, leaving now a good clear pond for fish-culture. We would like to have some more carp.

339. *Statement of Jacob Dick, Beaver Creek, Washington Co., Md., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 50 carp in March, 1881. I put them in a pond 25 feet wide, 35 feet long, and 4 feet deep, with a muddy bottom. There is about water enough to keep it at that depth, or deeper if I want it.

PLANTS AND ENEMIES.—It contains peppermint and water-cresses. There are no other fish, frogs, or turtles in it. The snakes and kingfishers, however, destroyed all the carp except one during the first summer.

FOOD.—When I got the carp I fed them twice a week with corn-meal and worms.

MISCELLANEOUS.—I will send after some more. I think they will do well if I can get them started.

340. *Statement of D. H. Newcomer, Benevola, Washington Co., Md., Aug.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—I received 75 leather carp two years ago and 90 scale carp a year ago. I have kept them in a pond 80 feet long, 14 feet wide, and 4 feet deep, gradually diminishing to 6 inches deep at the head or spring. The shallow part is gravelly and the deep part loamy. From 50 to 100 barrels of very cold limestone water flow through it in a day. I think soft spring water would be better adapted to the growth of the fish. I intend to enlarge my pond, which will put it farther from the head spring. I think they will then do better.

PLANTS.—I put into the pond some water-cress, which grows winter and summer and forms a good protection to the fish. It grows on top and the roots do not extend to the bottom.

ENEMIES.—There are some few common suckers in the pond and some frogs, which I do not think will be of any injury. I have much trouble in keeping out musk-rats.

FOOD.—I feed them with bread, but not at regular times; once a week, upon an average. I know that they would not eat much more if they had it.

GROWTH.—About 40 of the first lot are still left. They are not uniform in size, but the largest are about the size of ordinary shad. The one-year olds are 4 inches long. The last young are very small. I think my carp would grow faster in soft water.

REPRODUCTION.—The scale carp produced young a year ago, which, I think, will do well. A few days since I noticed a small drove of quite young ones.

DIFFICULTIES.—I notice that some of the carp get white specks on them. Perhaps this is caused by their running against stones.

341. *Statement of John D. Wisherd, Benevola, Washington Co., Md., July* 31, 1883.

DISPOSITION OF CARP RECEIVED.—Two years ago last March I received 50 carp. I have kept them in a pond 90 feet long and 30 feet wide, with a depth of 3 feet at one end and becoming quite shallow at the other. The bottom is marshy. The pond is fed by a strong never-failing limestone spring. The temperature of the water is 56°.

PLANTS.—It contains water-cress, grasses, and a green moss with a peculiar musk-like scent.

ENEMIES.—It has a few spring-water suckers in it and a few small frogs, but no turtles. Snakes and kingfishers have made me much trouble.

FOOD.—I feed the carp occasionally with corn-meal and skimmed milk.

GROWTH.—It is impossible for me to say how many of the original ones are left, owing to the thickness of the moss. We have caught but one; that weighed about 3 pounds.

REPRODUCTION.—The young are innumerable, and are of different sizes and weights.

MISCELLANEOUS.—My pond was only for an experiment. I can enlarge it to about the size of an acre if I find it profitable. I think fall is the best time to put carp in a pond, as by spring they will be too large for the snakes to manage.

342. *Statement of Emanuel H. Frantz, Clear Spring, Washington Co., Md., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—In the fall of 1880 I received 50 carp 3 inches long, and this June I received 12 more. I constructed a pond for them 25 by 50 feet, and 3½ feet deep, on an average. Its bottom is composed of mud and gravel and rotten leaves. It is fed through an inch iron pipe out of a mill-race. The water is cold mountain spring-water, and is brought by the mill-race from a dam in a gorge of the first spurs of North Mountain.

PLANTS.—The pond contains some water-lilies and common green plantain. A large sycamore tree shades it on the southwest.

ENEMIES.—There are small frogs in it, and I am also troubled a great deal with small fresh-water crabs, which make holes in the dam so that the water leaks out.

FOOD.—The first year I fed the carp principally with water crackers and refuse from the kitchen; since then with various vegetables, bread, &c.

GROWTH.—They are now 8 or 9 inches long, and weigh 2 pounds or over.

MORTALITY.—They did all right until this spring, when all at once they came to the top as though perishing for fresh air, and died in 12 hours, all except 3. I cannot account for the loss, unless it was caused by poison or snake-bites. After they had commenced to die I let the pond off and had it well cleaned out, but found nothing but one small water-snake, and crabs and tadpoles. I had just constructed a new dam lower down, so as to make a pond 80 yards long, 50 yards wide and 5 feet deep, and intended to plank it up tight, when I lost all my labor in a single week.

MISCELLANEOUS.—I would like to get a start again. I have well boarded up my new dam, and it will make a splendid place for the carp.

343. *Statement of Rev. Daniel Wolf, Fair Play, Washington Co., Md., Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—I received 75 carp December 21, 1880. I have kept them in a pond, which is triangle-shaped, each side being 160 feet in extent. Its depth is 2 feet, and it has a bottom composed of very hard, white marl; but black loam washes in continually. The water comes from 2 strong springs about 500 yards apart; that from each enters at a different corner of the triangle, but there is only one outlet.

PLANTS.—Water-cresses and lettuce grow along the branches and about the spring, to which the carp have access.

ENEMIES.—There are some frogs, and the small turtles that are common to ponds. Water-snakes, musk-rats, and cranes prove enemies to the carp, and I believe that geese and ducks destroy them. [See also under GROWTH, below.]

FOOD.—The carp are so shy and disposed to conceal themselves that we never attempted to feed them. One or two of them have been detected on several occasions in picking up particles of starch dropped in the water on wash days.

GROWTH—There are no old carp left that I can discover. The same night when they were first put in, the ponds and the spring froze over thick with ice, and remained so all winter. I did not see any of the fish until the following September. Then I saw some 14, which seemed to be about 7 inches long; and at that time I discovered a shoal of young black bass about the size of a half-bushel,

REPRODUCTION.—There must have been several thousand young ones. After they get to be from 5 to 6 inches in length we cannot see them any more. I have never weighed any of them.

DIFFICULTIES.—My pond is surrounded by low lands which once a year, or oftener when there are very heavy rains, get flooded over to the depth of 18 inches or more; consequently, the fish can be, and I have no doubt are, carried to the Antietam Creek, and are lost to me.

344. *Statement of H. C. Loose, Hagerstown, Washington Co., Md., Sept.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—May 13, 1881, I received 50 scale carp, but the weather was so very warm that only 34 were living. I received 99 more, December 5, 1881, all living.

I have kept them in a pond ¼ of an acre in extent, with a depth of from an inch to 4 or 4½ feet, sloping to the under drain corner, after Rudolph Hessel. It has a marly bottom, with no rock. The amount of water flowing through it is usually about an inch, but I can run from ½ an inch to 10 inches of it through the sieves in a trough 14 inches wide. The water is slightly cooler than river or creek water, coming from a stream fed by springs, of which the most remote is 10 miles away, and the nearest is within half a mile.

PLANTS.—The pond contains no water plants nor grasses, except one water-lily, *Netumbium speciosum.* Other *Nymphæa* were planted, but failed to grow.

ENEMIES.—It contains some suckers, whose eggs must have washed through the screens; also a few "skill-pots," and, possibly, a few frogs. I am troubled with musk-rats, and, occasionally, a large fish-hawk. I don't know whether "skill-pots" hurt, but try to kill all I can. There are no snapping-turtles.

FOOD.—We feed the carp about twice a week during the growing season, say from May to November; principally with cracked corn, unsifted, but also with stale bread and any vegetables that are left over from the table, such as green corn, cabbage, potatoes, &c. Occasionally we give them screenings.

GROWTH.—I have 23 that I know of left from the first lot; the largest are 19 inches long and 11 inches in girth, and weigh 2 pounds and 13 ounces; some are 18½ inches long, 11½ inches in girth, and 2 pounds and 13 ounces in weight; and others weigh 2 pounds and 12 ounces. I can't say how many of the second lot I have, but a goodly number. Some of these are 12½ inches long, and weigh 1 pound; some are 11½ inches long, and weigh 11 ounces; and some measure 11¼ inches, and weigh 11 ounces. The young ones are from 2 to 7 inches long. My large carp do not weigh ½ ounce more than they did July 26, 1882, and are only half an inch longer. The second lot are larger than in July, 1882, but not very much; I did not measure them then, so I can't tell exactly. Only the smaller ones (my own hatching) appear to grow. Are they only rapid growers when small?

REPRODUCTION.—Last year some few were spawned by the first lot, and this season both lots spawned. I have hundreds of young ones now; it is impossible to number them; would guess that there are from 200 to 400 or 500.

EDIBLE QUALITIES.—I have just given away 3 of the first lot (not the largest) and 3 of the second. These were all used for the table, and, together with several eaten in my own family, were pronounced by all to be very fine eating.

HOW TO CATCH CARP.—One time I kept the water supply out of the pond for some days, getting it quite low (without opening my underdrain). I then put in 2 good-sized stir-nets, but could not catch a fish. Then I tried a dip-net, but still could not catch any. I did not like to use hook and line, as I did not wish to injure any, and might possibly catch one I did not want. So any one having a pond which he is not able to drain may have plenty of carp, although he finds it almost impossible to catch any.

The day I inspected the pond I put into it, near the shore, in order to avoid the above difficulty, a live-box, 12 feet long, 2½ feet wide, and 2½ feet high, substantially framed with 4 by 4 white oak, and stout slats 1½ inches by 1¼, having a board bottom and slat sides and ends, and being provided with two slat lids, both of which I have under lock and key. I sunk the box in the mud below the 4 by 4 cross sills, and also put some 3 or 4 inches of mud on the board bottom. Into this pen I put 3 carp of the first lot (not the very largest) and 9 of the second lot, so that I shall be able to get them with a scoop-net when wanted either for the table or to satisfy visitors' curiosity

345. *Statement of Jonas Bell, Williamsport, Washington Co., Md., Aug.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—I received 40 carp a year ago last fall. I have a large spring, and I put them in a store-box through which the water passed. Last August I gave them green corn. The ducks got in and eat all of them. When they were killed they were 3 inches long. Will try again.

346. *Statement of Randolph Humphreys, Salisbury, Wicomico Co., Md., July* 24, 1883.

Disposition of carp received.—The young carp that you sent Gen. Humphrey Humphreys were placed in a small area, inclosed by a wire guard. He was unfortunate enough to have the wire broken, about 5 months after they were put in, and since then the carp have not been seen. It is supposed that they were devoured by the numerous large pike that abound there. While they were in the pond they were well fed and seemed to thrive. General Humphreys died in May, 1882.

347. *Statement of Joshua E. Carey, Berlin, Worcester Co., Md., Aug.* 20, 1883.

Disposition of carp received.—I received 80 leather carp 2 years ago last December. I have kept them in a pond about an acre in surface, from 1½ to 2 feet deep, with a muddy bottom. Water flows through it about ½ of the year. In winter it is very cold, so long as the springs are kept up by the rains.

Plants.—There are lilies in the pond, three-square and bent grass, pepper-grass, blue-grass, and some others.

Enemies.—It also has in it catfish, pike, sun-fish, frogs, and turtles; and there are musk-rats in its banks. When I first prepared the pond I passed all of the water through a fine basket, so as to get rid of other fish, but I see there are plenty in it yet; and I think that they have destroyed a great deal of carp spawn. Fish-hawks have probably caught some of the old carp.

Food.—I have not fed the carp but once since they were put in. There is plenty of food there.

Growth and reproduction.—I am not able to state how many of the original carp there are in the pond at this time. I see quite a number. They are 18 inches long and 5 broad. I have not seen any young ones yet, but hope there are some in the grass which covers the bottom of the pond. There are trees standing in the pond so that I cannot haul a net in it.

MASSACHUSETTS.

348. *Statement of John Birkenhead, Mansfield, Bristol Co., Mass., July* 31, 1883.

Disposition of carp received.—I received 6 carp in Nov., 1880. The pond is 30 by 40 feet, and about 2 or 3 feet in depth, and contains peat and gravel. It was not a success, as I suppose the frost reached the bottom of the pond.

349. *Statement of Emory C. Harris, Colerain, Franklin Co., Mass., Oct.* 14, 1882.

Growth.—I received last November 21 carp, all alive and healthy, and I put them into a large spring of water; but they all died but 3. These I put into my pond, 40 by 220 feet, and they are now nice fish, averaging 12 inches each.

350. *Statement of James S. Grinnell, Greenfield, Franklin Co., Mass., July* 26, 1883.

Disposition of carp received.—I received 15 carp in October, 1881. I put them in a small pond 10 to 12 feet across and fed by a spring, intending to transfer them to a larger one. When I came to transfer them, however, they were not to be found.

Enemies.—We killed a couple of water-snakes, which accounts for the loss of the carp. I am greatly interested in fish-culture and purpose trying again.

351. *Statement of James W. Hannum, Ludlow, Hampden Co., Mass., July* 28, 1883.

Disposition of carp received.—I received carp in the fall of 1881 and again in the spring of 1882. I put the first lot in a small pond near the house. They all disappeared and I think were caught by an otter. The second lot I kept in a spring during the summer and transferred them in the fall to a wire cage, 3 feet cube, and anchored in a pond covering 20 acres.

Enemies.—I have not let them out in the pond on account of other fish—pickerel, catfish, &c.

Food.—I have given them boiled Indian meal.

Growth.—They are nearly the same size as when I first received them. I think the water is too cold for carp, or they would increase in size faster.

352. *Statement of William F. Martindale, Enfield, Hampshire Co., Mass., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp in November, 1880. My pond is 60 by 80, with an annex of 12 by 40 feet. The water is from 1 to 5 feet deep. The bottom is muck and yellow loam. The water comes from springs 20 rods distant in quantity enough to fill a 2-inch pipe. Its temperature August 2 was 52° at the spring and 66° at the pond.

PLANTS.—The pond contains a fine round water grass that the fish pull from the bottom and eat. There is also a common water vine.

ENEMIES.—The pond contains no other fish, but some frogs. A fish-hawk took one of the old ones and a water snake 2 or 3 of the smaller ones.

FOOD.—I feed them once a day on sweet-corn and rye, boiled, and on various kinds of grain and bread.

GROWTH.—Last September the 2-year old measured from 12 to 15 inches.

REPRODUCTION.—I do not know how many young there are. The pond appeared to have a large supply last fall.

DIFFICULTIES.—I think I have lost a part of the fish from the loss of water in the spring, caused by the action of frost on the dam, which is an artificial one. There has been no serious difficulty with the fish. I have been very much interested in them, and I think they will become of much value.

353. *Statement of Lorin Barrus, Goshen, Hampshire Co., Mass., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—Hiram Packard, whose pond I have bought, received 18 carp November 9, 1880. The pond covers an acre, contains mud and peat, and varies from 1 to 6 feet in depth. The influx at low water would fill a 6-inch pipe; at high water there is quite a volume. The temperature is from 60° to 70°.

PLANTS.—In the shallow water there grows coarse grass, a sedge eel-grass and a mixture of fine grass and moss.

ENEMIES.—I have seen a few small frogs, a few small dace, and occasionally a small brook turtle.

FOOD.—I have not fed them, but I think there is an abundant natural supply.

GROWTH.—The 4 that remain would weigh in May, when I drew the pond off, from 5 to 6 pounds each. One of them measured 19 inches in length. The first year they weighed 1 pound, the second 3 pounds, and now, 6 pounds. Three of them look alike, having scales with the same general appearance, about as large as a thumb in length. The fourth one has scales twice as large and of a brighter color.

REPRODUCTION.—There is an appearance of some young fish in schools on the top of the water occasionally, but they vanish when one approaches. I am uncertain whether they are carp. I intend to stock another pond shortly.

DIFFICULTIES.—The pond froze over the night I had put the carp in, and I think they failed to find good winter quarters.

354. *Statement of John L. Shorey, Cambridgeport, Middlesex Co., Mass., Sept.* 15, 1883.

DISPOSITION OF CARP RECEIVED.—Three years ago I received through Mr. E. A. Brackett 7 very small carp and put them in a muddy pond where there were a good many frogs. I have seen no trace of them since and think the frogs have eaten them up.

355. *Statement of Geo. M. French, Holliston, Middlesex Co., Mass., Aug.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp in July, 1880. The pond, or lake, covers 450 acres, is from 25 to 30 feet deep in the deepest place, has a bottom of mud, gravel, and sand. It is fed by springs only. We put the carp in an artificial pond side of this lake and think they escaped into the lake.

ENEMIES.—The lake contains natural fishes, such as pickerel, perch, catfish, shiners, suckers, and besides is being stocked with land-locked salmon, white perch and trout.

356. *Statement of T. J. Marsh, jr., Tewksbury, Middlesex Co., Mass., Dec.*, 1882.

DISPOSITION OF CARP RECEIVED.—The 400 or 500 carp received by the State Fish Commissioners in the fall of 1880 were placed in the reservoir of the Tewksbury almshouse for several reasons. First, they were received too late in the season to prepare a pond for them; secondly, to give a chance to test their expense. The water is cold spring-water from what formerly was a trout stream. The bottom of the pond is paved with stone. The low temperature of the water prevents vegetable growth, and consequently renders it an unfavorable place for carp.

FOOD.—I feed the carp with stale bread from the almshouse.

GROWTH.—They have grown finely, many of them weighing from 1½ to 2½ pounds. With a grassy bottom and a higher temperature they would probably have doubled their size. This shows the rapid growth under adverse circumstances. Many of the fish are large enough to spawn next summer.

357. *Statement of Simon W. Hatheway, Islington, Norfolk Co., Mass., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—I have been feeding carp to vipers, and am now engaged in killing the vipers (or water snakes), an occupation which gives me much pleasure. When I get the vipers killed I will try carp again.

358. *Statement of Martin Greer, Green Hill, Worcester, Worcester Co., Mass., Aug.* 11, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp November 19, 1880, 31 November 10, 1881, and 19 November 18, 1881. I estimate that the pond contains 70 acres, with an average depth of 15 feet. It contains peat, muck, and the ordinary swamp grass. The temperature August 7, 1881, was 70°. It is fed entirely by springs, and overflows all the year except summer.

ENEMIES.—It contains frogs, snapping and speckled turtles.

GROWTH.—In the spring of 1881, while a temporary gate was removed for letting the water off, most of the first lot of carp escaped. September 24, 1881, I found 1 carp remaining, which was 14½ inches in length, having grown 12½ inches since November 19, 1880.

DESTROYING OTHER FISH.—At that time I bailed out many other fish, such as catfish shiners, perch, and flat-fish. I then worked into the mud 10 pounds of quick-lime to destroy all other fish before again introducing carp.

REPRODUCTION.—During the spring of 1883, fish 6 or 8 inches long have been seen, supposed to be carp, but, as it is not convenient to draw off the pond, I cannot now state the condition of the fish.

MICHIGAN.

359. *Statement of C. C. Sutton, Millburgh, Berrien Co., Mich., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 10 carp, 5 scale and 5 leather, in January, 1880. On receiving them I put them in a hatching trough for a short time and then placed them in a pond 8 by 12 feet which had been used for a trout nursery. I supposed the trout were all out, but there was 1 left, and in 24 hours he had partially eaten them up, so much so as to kill them. I have given up trout-culture and want some more carp. There was no difficulty except the cannibal trout.

360. *Statement of P. B. Tuttle, Niles, Berrien Co., Mich., June* 13, 1884.

DISPOSITION OF CARP RECEIVED.—The pond in which my carp are is excavated in muck soil, which naturally is full of vegetation. The depth varies from 1½ to 5 feet. The pond can be drained entirely dry in a few hours. The flow of water can be regulated from 1 to 40 inches, and is every way adapted to the propagation of carp.

Another pond adjacent to this, with a larger area, is adapted to the keeping of breeders. As soon as the carp are hatched in the small pond, the larger carp are removed to this pond and kept separate from the young carp. My fishery was constructed by the Michigan commissioners, and the estimated cost of ponds and building was $5,000. It was given up by the State because the water proved too warm for the culture of speckled trout.

REPRODUCTION.—I have between 40 and 50 carp 3 years old. A few young were hatched last season, but were lost by a defective gate. Four years ago thousands of young carp were raised here, and carp grew in 14 months to weigh over 7 pounds. I would like to undertake the breeding of trout, and would be glad to exchange some carp for some of your trout at Northville.

361. *Statement of Martin Metcalf, Battle Creek, Calhoun Co., Mich., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—In the summer of 1880 I received some carp and put them in a small spring, from which they were lost. I received the second lot in the summer of 1881, and the third lot in 1882. The first winter I kept them in a large muddy-bottom spring pond, and transferred them in the spring to a muddy bottom and weedy pond cut off from running water. As there is no circulation in hot weather the water gets very warm.

PLANTS AND ENEMIES.—The pond contains water-cresses, flags, and some frogs, but nothing else objectionable.

FOOD.—I feed the carp with refuse from the kitchen, farm, &c., including both raw and cooked corn, potatoes, &c. I feed them once in three days.

GROWTH.—Of those received in 1881 there are 4 left, which probably averaged ¾ of a pound last October, which was a fine growth considering that I did not feed them any in 1882 and the water was of quite low temperature. Of the lot received in 1882 there are about 100. I have seen no young.

362. *Statement of A. Garwood, Cassopolis, Cass Co., Mich., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp and kept them until this spring in an excavated pond 12 by 40 feet. This spring I put them in a pond twice as large, and as I let but little water flow into it it was warm.

PLANTS AND ENEMIES.—Being new it contains but little vegetation. It also contains frogs.

FOOD.—Most of the time I feed them with light bread once a day.

GROWTH.—I have 6 of the lot left, which are 15 inches long and 4 pounds in weight. They have produced no young.

DIFFICULTIES.—Those that I lost died during the winter, under the ice. I suppose the water was so cold through the summer as to prevent their spawning.

363. *Statement of Junius H. Hatch, Lansing, Ingham Co., Mich., July* 20, 1883.

DIFFICULTIES.—I have given fish-culture much attention and think the majority of failures occur through ignorance of the food and water necessary for development and growth of fish. I have frequently known white fish, trout, &c., being lost simply because they were dumped in waters teeming with predatory fish. This is a great obstacle to successful carp-culture here. Michigan, particularly in the southern part, is full of small, shallow, weedy, land-locked ponds, sometimes called sink holes, and peculiarly adapted to carp-culture.

364. *Statement of J. C. Sterling, Monroe, Monroe Co., Mich., Dec.* 10, 1883.

CARP IN LAKE ERIE.—One of our Monroe fishermen found in his catch of whitefish one day last week a fine specimen of German carp which weighed 3¾ pounds. The pound from which the fish was taken is in Lake Erie, about ¾ of a mile out from the mouth of Raisin River.

365. *Statement of Samuel Alexander, Birmingham, Oakland Co., Mich., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp in the fall of 1880 and put them in a pond 12 by 20 feet and 3 feet deep, with a gravelly bottom. The flow of water is boundless from a clear and cold spring, excellent for drinking. It contains many plants.

ENEMIES.—There are no other fish nor turtles. If I were to guess the number of frogs I would say about 1,000,000,000,000,001.

MISCELLANEOUS.—They began to die immediately, and in the course of a few weeks all were dead. I conclude that the Michigan people who can get such excellent native fish as the whitefish, trout, bass, and pickerel will never put a very high estimate on carp. The frogs did not appear until the carp were dead, and I think to raise any kind of fish we should be obliged to exclude frogs and minks.

366. *Statement of Cornelius J. Lawrence, Southfield, Oakland Co., Mich., Sept.* 15, 1883.

GROWTH.—One of my neighbors got German carp from you last fall which are now 1 foot long, and I would like to raise some.

MINNESOTA.

367. *Statement of L. Z. Rogers, Waterville, Le Sueur Co., Minn., Sept.* 26, 1883.

DISPOSITION OF CARP RECEIVED.—In April, 1881, I received 25 carp. I put them in a pond of 1 acre. I received a second lot in December, 1881, and put them in a 4-acre pond with water 10 feet deep. The water is very clear. The bottom is muddy and sandy, and there is no inlet nor outlet. Another lot received last spring I put into the latter pond.

ENEMIES.—The small pond contains no other fish, but contains small turtles and common wild duck. The second pond contains no fish except the carp; has plenty of vegetation and insects.

GROWTH.—After depositing the first lot I saw nothing of them, although I looked carefully all last summer, but in April of this year, just 2 years after depositing them, I found 3 old ones, each 21 inches long and weighing 6 pounds each. They had been dead a long time and appeared quite shriveled. My man claims to have seen during this summer a large and a small one also in the pond. To-day I looked in the large pond for carp, but saw none. I think, however, there must be some under the vegetation, which is very thick.

368. *Statement of R. O. Sweeny, St. Paul, Ramsey Co., Minn., Mar.* 27, 1883.

MORTALITY.—With few exceptions, the first lot of carp appeared to be in excellent condition when received. But they are evidently now, or were then, under the influence of a peculiar disease which is rapid and fatal, for they die in large numbers. Before death there is a remarkable bloating and protrusion of the eyes from the sockets in a singular manner as if the whole carcass was distended to bursting, yet remaining remarkably limp and free from *rigor mortis* so usual in small fish when dead. The healthiest and more vigorous ones prefer the cooler current through the center of the tank, while the weak and sickly ones mope about in the quiet corners where there is but little or no motion to the waters.

369. *Statement of John Fisher, Stillwater, Washington Co., Minn., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp in November, 1880, and 20 in November, 1882. My pond or lake will average 65 rods wide and 90 rods long, with 5 feet of water and 1 foot or more of mud. It is land-locked, having no inlet or outlet. The water is icy cold in winter.

PLANTS.—It contains pond-lilies, common water-grass, and many kinds of weeds.

ENEMIES.—Frogs are plenty, and a small kind of turtle, sometimes called terrapin. I think the first lot were all taken out by a kingfisher.

PROTECTION FROM ENEMIES.—If I could get some more that would attain considerable size before winter, so as to be able to stand the cold, I would protect them by putting down a crib of boards 12 by 21 feet, or larger, sinking them in the muddy bottom where the water is deep, and then make a slat covering to protect them from kingfishers. I could then feed them and keep them away from their enemies until they begin to breed.

FOOD.—Until the lake froze over, I dropped in mixed cornmeal and flour and dough near the place where I put the carp. I have not fed them since.

DIFFICULTIES.—I have never seen any carp since a few days after putting them in. There seems to be no difficulty, unless perhaps a slight tincture of oxide of iron, in the water. Other lakes and streams in this vicinity freeze to a depth of 20 inches. My pond has never shown over 17 inches of ice.

OTHER FISH.—Seeing no signs of carp, in the summer of 1881 I put in some mullet, red-horse, sunfish, bass (or crappie), and pout (catfish), all from Lake Saint Croix, together with 15 bass from a land-locked lake 4 miles away. All of the red-horse and mullet and some of the sun-fish and pout have been found already along the shore. None of the bass have been seen, but the lake is full of pouts of every size. The red-horse and mullet were never seen until found dead, after being in the pond two winters. The bass and carp may be there, but I do not think so.

370. *Statement of John K. McLean, St. James, Watonwan Co., Minn., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp in 1881 and 20 in 1882, and put them in a small lake, with a bottom of mud and sand. There I left them, and have taken no particular care of them since.

371. *Statement of H. C. D. Ordorff, Monticello, Wright Co., Minn., Oct.* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp in October, 1881, and a second lot in November, 1882. My pond covers about ¼ of an acre; it has from 3 to 4 feet of water, and 9 feet of marsh. In winter it freezes to a depth of from 24 to 30 inches. Water flows through it in spring, the outlet being protected by a wire screen. I made a pool 16 feet square and 6 feet deep near the pond, in which I put the first lot, but they all got out. I put the last ones into the pond, and have never seen them since. I do not know how many are left, or whether they have produced any young.

PLANTS.—The pond contains water-lilies, and its bottom is overgrown with moss and weeds. It yields no better than the carp ponds in Germany.

ENEMIES.—There are bull-heads, minnows, two kinds of turtles, and a great many large frogs in it.

FOOD.—I fed my first carp once a day with lettuce and bread.

MISSISSIPPI.

372. *Statement of W. F. Moore, Corinth, Alcorn Co., Miss., Aug.* 1, 1884.

GROWTH.—The carp received in the fall of 1883 have done well, and they now measure from 8 to 12 inches in length.

373. *Statement of M. J. Rimmer, Kosciusko, Attala Co., Miss., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—In the fall of 1880 I received 25 carp, and have received 10 since. The pond is muddy and stumpy; the water clear and tolerably cold, as it comes entirely from springs. The pond covers about 1½ acres, having a depth of 10 feet.

PLANTS.—There are the plants which usually grow about ponds, also willows.

ENEMIES.—There are bream, catfish, perch, silversides, hardshell turtles, &c.

FOOD.—I have given them corn and wheat bread, cabbage, beef, and worms.

GROWTH.—I should think they are about 18 inches long and weigh from 8 to 10 pounds. They are so wild we see little of them.

REPRODUCTION.—I have not noticed any young until this season. Now there are a great many from 2 to 3 inches in length.

DIFFICULTIES.—Owing to neglect, we have been troubled with turtles. It is difficult to catch the carp.

374. *Statement of A. E. Bagwell, Rocky Springs, Claiborne Co., Miss., July* 30, 1882.

HOW TO CATCH CARP.—I have German carp in my pond which are doing finely, but it is impossible to catch them with a hook.

375. *Statement of G. V. Young, Waverly, Clay Co., Miss., Aug.* 25, 1883.

DISPOSITION OF CARP RECEIVED.—My brother, W. L. Young, procured some carp about 2 years ago and placed them in a pond fed by an artesian well. It became necessary this summer to get rid of the small fish, most of them being minnows of the variety known as silversides. The pond was drained and the carp were placed in the bath-tub, where they remained 4 or 5 days. This tub or tank is 10 feet square and about 5 feet deep, and was constantly supplied with pure water. My brother subsequently placed the carp in the fish pond and let on a limited supply of water, where everything could be observed.

FOOD.—The carp were fed daily.

DIFFICULTIES.—They soon became very restless, and finally a fine specimen jumped out and was found dead. The carp was examined, and it proved to be a female in condition for spawning.

HABITS.—This restlessness on the part of the carp seemed to be a desire on the part of the females to avoid the males. The male carp in some instances forced the female out on the land.

376. *Statement of Wm. L. Young, Waverly, Clay Co., Miss., July* 31, 1883.

DISPOSITION OF CARP RECEIVED.—I received about 150 carp February 22, 1881. My pond is 40 by 120 feet, 4 feet deep, with a bottom of bluish pipe-clay. It is fed by an artesian well yielding 10 gallons per minute, and of about 60° temperature. There are no plants nor grasses in it.

ENEMIES.—There are sun-perch, a few mud-cats, and millions of minnows.

FOOD.—I have given them corn-bread about 4 times since putting them in the pond.

GROWTH.—Thirty-nine remain, which would measure 15 inches on the average.

REPRODUCTION.—There has yet been no young, but they are now full of eggs and appear to be about mature.

DIFFICULTIES.—The only difficulty has been to keep the carp from escaping at the outlet. The pond has just been cleaned and the defects remedied.

377. *Statement of E. R. Brown, Hazelhurst, Copiah Co., Miss., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in the spring of 1882. I have a pond 90 by 180 feet, with a muddy bottom and a depth of 12 feet. It is supplied entirely by surface rain-water.

ENEMIES.—It contains perch, frogs, and hardshells, but no plants.

FOOD.—They have all the food they can get from nature, and whenever they want it.

MISCELLANEOUS.—I know nothing of the old ones, nor have I seen any young ones. I found it difficult to catch any.

378. *Statement of E. G. Peyton, Hazlehurst, Copiah Co., Miss., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp late in 1880 and 20 mirror carp last year. I have 2 ponds with muddy bottom; one 100 feet by 200, and the other 100 by 150 feet, and from 3 inches to 10 feet in depth. The ponds are supplied by spring water, and at this season of the year it is warm and the carp seem to thrive in it.

PLANTS.—The ponds contain grasses.

ENEMIES.—There are plenty of frogs and craw-fish and one or two turtles. Two large catfish were found in the pond December, 1882.

FOOD.—I feed them once a day on scraps from the table, bread, potatoes, lettuce, corn, chops, &c.

GROWTH.—There are 8 of the first lot which are not less than 2 feet in length, and weigh from 5 to 7 pounds each. November, 1881, 7 of the carp were 16 inches long and weighed 2 pounds; March, 1882, they were 18 inches long, and on draining the pond, December 15, 1882, I caught 24 large carp measuring 16 inches in length and weighing 2 pounds. These were planted in the winter of 1881–'82.

REPRODUCTION.—Last year they produced about 300 young, which are now from 7 to 15 inches in length. The carp were more backward in spawning this than last season. By May 15, 1883, there were young 1 inch long. I first saw young carp in my pond in April, 1882. I drained the pond December, 1882, and found 275 young, some as large as good-sized eating perch, and others from 3 to 6 inches long at the time named.

DISPOSITION OF YOUNG.—I supplied some of my neighbors with young in 1882. I sold about 200 of them.

DIFFICULTIES.—My most serious difficulty has been to keep turtles, frogs, craw-fish, and snakes out. I fear the craw-fish and frogs eat the eggs of the carp.

379. *Statement of William Oliver, treasurer of Mississippi Mills, Wesson, Copiah Co., Miss., May* 2, 1883.

GROWTH.—I received 18 carp, from 3 to 4 inches long, November 18, 1881. About 2 weeks ago a carp was killed in one of my ponds and found to weigh 15 pounds gross, and measured 2½ feet in length.

EDIBLE QUALITIES.—Those who ate the carp say it was as fine as trout.

380. *Statement of W. W. Kelsey, Lewisburg, De Soto Co., Miss., Nov.* 5, 1882.

GROWTH.—The fish I received last December are doing well, and they will weigh from 1½ to 3 pounds.

381. *Statement of G. W. Mason, Lewisburg, De Soto Co., Miss., July* 17, 1882.

GROWTH.—The 20 carp received in December, 1881, were seen in May, 1882, for the first time since they were placed in the pond. As seen in the shallows they appear sufficiently large for table use. They grow and thrive well in our waters, and when called come for food like pigs. I have seen no young yet.

382. *Statement of John Yost, Brandon, Franklin Co., Miss., July* 30, 1882.

DISPOSITION OF CARP RECEIVED.—About the middle of December, 1881, I received 20 carp and placed them in a box 2½ feet square by 20 inches deep. I bored a number of small holes to allow the free circulation of the water running from the spring, and put a rock and a few shovelsfull of dirt in the box to hold it down. I have two adjacent ponds, and in one I subsequently placed all the carp.

FOOD.—I feed the carp on cabbage leaves, lettuce, tomatoes, peaches, apples, and crumbs of corn-bread.

ENEMIES.—The carp were placed temporarily in the box until the pond could be rid of the sun-fish, bream, and catfish which inhabited it. I placed these fish in one of my ponds.

GROWTH.—A carp was captured the first day of the present month which was 12 inches long. This carp was 3 inches long when placed in the pond, and shows a gain of 9 inches in length in 6 months.

HOW TO CATCH CARP.—A 12-inch carp was caught with worm used as a bait.

DIFFICULTIES.—When I had prepared my pond for the reception of the carp I found 10 under the rock in the box dead. That left me 10 live carp, and they were sick. In taking the carp from the box one accidentally fell into the pond with the catfish and bream. This was the one caught with the hook. I have not seen the others since they were transferred from the box to the pond.

383. *Statement of Calvin W. Barber, Edwards Depot, Hinds Co., Miss., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in December, 1880. My pond covers $\frac{3}{4}$ of an acre, averages 3 feet in depth, and has a muddy bottom. It is supplied entirely by surface water from about 2 acres of land, and is quite warm.

PLANTS.—It contains no plants except Bermuda grass and willows.

ENEMIES.—It contains two species of perch, as well as bream, and frogs. I shall also need to guard against turtles.

FOOD.—Three times a week I give them corn, vegetables, &c.

GROWTH.—I have all of the old ones, and they will weigh from 8 to 10 pounds each. I have not seen any young yet.

384. *Statement of Thomas Atkinson, Jackson, Hinds Co., Miss., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 19 carp December 24, 1880. My pond covers $\frac{3}{4}$ of an acre, is from $1\frac{1}{2}$ to 6 feet deep, and has a muddy bottom. The water is still, except when there is an overflow from heavy rains.

PLANTS.—Bermuda grass grows around the edges, and willow trees with a large number of roots extending out into the water.

ENEMIES.—The pond contains some catfish and perch.

FOOD.—I feed them when convenient with corn-bread, stale crackers, meal, cabbage, turnips, and other vegetables.

GROWTH.—On the 19th of September, 1881, I drew off the pond, and found 7 carp from 12 to 14 inches long. I have not been able since to ascertain whether they have any young.

DIFFICULTIES.—The most serious difficulty has been to keep out other fish and to supply aquatic plant food.

385. *Statement of A. N. Kimball, Jackson, Hinds Co., Miss., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp in January, 1880, and 20 more in December, 1882. My pond is 30 by 50, supplied by rain only, has a muddy bottom, and is from 2 to 5 feet deep. In the winter water flows through it abundantly. In the summer it is scarce and very warm.

PLANTS.—It contains willows and thick-leaved grasses, such as usually grow in swamps and wet places.

ENEMIES.—These are silversides, perch, and small loggerhead turtles, which have been caught with hooks. Birds, especially herons, frequently alight in the pond.

FOOD.—At irregular intervals I have given them boiled potatoes, corn-bread, and crackers.

GROWTH.—In January, 1881, there were 9 left; in September, 1882, there were 5 left. In January, 1883, these 5 old carp weighed from $4\frac{1}{2}$ to 5 pounds each.

REPRODUCTION.—In May, 1883, I sank a dip-net 30 inches in diameter, baited with bread, and caught about 15 carp not over an inch long. I have not seen them since June, and then only as they came to the surface to feed. They appear to be about 2 inches long.

DIFFICULTIES.—My most serious difficulty has been the fish of prey and turtles. The flood of February, 1882, may have carried off some carp.

386. *Statement of J. H. Odeneal, Jackson, Hinds Co., Miss., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp in January, 1882. My pond is 120 feet in diameter, with a muddy bottom. There is very little overflow and the water is very warm.

PLANTS AND ENEMIES.—It contains water-grass and Bermuda grass, but no enemies.

FOOD.—I give them boiled corn and scraps of vegetables.

GROWTH.—As nearly as I can tell, they are about 14 inches in length.

REPRODUCTION.—They have produced a great many young, but I am afraid that the hogs have eaten many of them.

387. *Statement of Rev. Azel Hatch, Tougaloo, Hinds Co., Miss., Feb.* 9, 1884.

DISPOSITION OF CARP RECEIVED.—The 22 young carp I received last spring were put in a pond of the Tougaloo University. The unprecedented drought of last summer dried out the pond to such an extent that the fish must have perished.

GROWTH.—About October 1, one was found which had floundered out of the mud, and measured 1 foot in length. It was dead when found.

388. *Statement of R. O. Lipsey, Goodman, Holmes Co., Miss., Oct.* 9, 1882.

GROWTH.—The carp which I procured last November have surpassed by far my most sanguine expectations. Though I have never caught or handled them, some of them will measure from 12 to 15 inches in length and weigh from 8 to 10 pounds. So well pleased am I that I have had my pond enlarged to about 2 acres.

PLANTS.—The pond is set with Bermuda grass, herd's-grass, and yellow clover. I have it arranged so as to regulate the supply of water.

389. *Statement of R. P. Heffner, West, Holmes Co., Miss., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in January, 1881. My pond covers 1 acre, is 6 feet deep, sloping back to 6 inches, and has a soft muddy bottom. It is supported by a good spring.

PLANTS.—It contains various grasses and weeds.

ENEMIES.—Catfish and perch. I have not seen any turtles.

DIFFICULTIES.—When I received the carp it was very cold. I had to cut ice 4 inches thick to put them in. As there were a good many other fish then in the pond, I think that is the reason why the carp did no better. I do not think any of them remain. If you will furnish some more I will drain the pond and have no other fish in it.

390. *Statement of Isaac W. Burch, Stonington, Jefferson Co., Miss., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp January 16, 1881. My pond covers 3 acres, averages 5 feet in depth, and has a muddy bottom. As there is no overflow except after heavy rains, the temperature is quite low.

PLANTS.—Water grasses of all kinds grow around the edges.

ENEMIES.—There are perch, hard and soft shell turtles, and plenty of frogs.

FOOD.—I don't feed them. They find plenty to eat.

GROWTH.—The old ones seem to be over 2 feet long, and look as if they would weigh 20 pounds or more.

REPRODUCTION.—The pond seems to be full of small fry, but some are quite large.

DIFFICULTIES.—We cannot catch them; have been trying all summer.

391. *Statement of W. V. Sneed, Oxford, La Fayette Co., Miss., Sept.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—I received 30 carp in 1880, and have received some since. My pond is fed by springs, covers 4 acres, and has a muddy bottom. The water averages 3 feet in depth and 60° temperature.

PLANTS AND ENEMIES.—It contains grass and moss, and also water-terrapins, perch, and trout.

FOOD.—I give them corn-bread once a week.

GROWTH.—I think the old ones will weigh from 5 to 6 pounds each.

REPRODUCTION.—They have produced a great many young.

MISCELLANEOUS.—They have been no trouble, and I think them profitable when proper care is given them.

392. *Statement of C. Adams, Sharon, Madison Co., Miss., July* 2, 1883.

DISPOSITION OF CARP RECEIVED.—The first lot of carp were received in good condition and placed in my pond in November, 1881. They failed to spawn before May, 1883. My pond covers about $\frac{1}{8}$ of an acre and is now low, 3 feet being its maximum depth.

FOOD.—I have fed the fish principally on cooked cornmeal or bread, chops, corn, and fruit, such as apples, peaches, pears, and plums, and also on the famous Southern stock feed, cotton-seed, and sometimes on meats. I believe they will eat anything, but I think they are more fond of chops and bread and the worms and maggots as they fall from a carcass suspended over the water. My young ones can now be seen in large schools catching them as they drop into the water.

GROWTH AND REPRODUCTION.—At 2 months old the young fish are from 3 to 4 inches long and fine fat fellows. I think 6 will weigh one pound. They grow fast and I think are large enough to eat when 6 months old. The old ones are about 16 to 18 inches long, and will weigh from 3 to 5 pounds. The second lot I received, on January 3, 1883, being then about $1\frac{1}{2}$ inches long, will now weigh from $\frac{3}{4}$ to 1 pound. In January, 1882, I was told by a man that his carp had grown from about 4 to 16 or 18 inches in length in about 8 months.

HOW TO CATCH CARP.—I tried, day before yesterday, catching the carp with a hook baited with a red earth-worm, and caught five in a few minutes, one of the largest, two of the second, and two of the third size, the last being this year's spawn. They took the hook quick and pulled well. Their mouths tore badly, and without caution I would have lost a great many, one of the second size having the side of its mouth torn almost off.

393. *Statement of Wallace and McGowan, Holly Springs, Marshall Co., Miss., Dec.* 4, 1880.

GROWTH.—A party to whom we gave carp last February put them in a small highland pond, and about a month ago took out one, which he says weighed over 3 pounds.

394. *Statement of A. Q. Withers, Holly Springs, Marshall Co., Miss., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—The carp, measuring about $1\frac{1}{2}$ inches long and weighing from 1 to 2 ounces, received December 17, 1880, I placed in a pond 200 feet square and from 1 foot to 6 feet deep, where they remained until June 26, 1881. Fearing that my pond would go dry and I lose my fish, I seined it and found 21 carp remaining. I gave 4 of them to Mr. Mathers, the owner of the seine, and removed the others to a cistern, containing about 1,000 barrels of cold water, and having a depth of 25 feet. I have placed turf and twigs in the cistern. I received another lot of 30 in the fall, 1881.

ENEMIES.—The pond contains no other fish, but some frogs inhabit it.

FOOD.—Up to the time of removing the carp from the pond, I paid no attention to them, as there was a sufficient quantity of food in the pond. I now give them corn bread and shelled corn weekly. During water-melon season I frequently sliced up melons for them, and they would congregate around the floating pieces and munch the red part like humans. The carp could be seen every day swimming around the cistern and feeding with their peculiar sucking sound.

GROWTH.—It was all we could do to get the 4 carp I gave Mr. Mathers into a common water-bucket, notwithstanding they were the smallest of the lot. The 3 which died within a few days after placing them in the cistern averaged 12 inches in length. The entire lot averaged $2\frac{1}{2}$ pounds. The remainder of the carp in the cistern ultimately died and would have weighed 3 pounds. The carp last received now weigh fully 3 pounds each.

REPRODUCTION.—Since the last lot spawned I have seen a school of young which I judge to weigh from 2 to 3 ounces.

DIFFICULTIES.—The water froze in the buckets when the first young carp were *en route* and 3 perished.

MISCELLANEOUS.—Before they died I had intended to let my 14 carp remain in the cistern, and to convert it into a hatchery so as to remove the young at the proper time to the ponds. When I seined the pond the carp showed some activity, floundering about, and when upon the surface of the water in the cistern they darted and floundered below with quite a noise when suddenly surprised. I would not sell my carp for $100 each if I could get no more.

395. *Statement of W. W. Cock, Hudsonville, Marshall Co., Miss., Nov.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1880, I received about 20 carp. They were kept in a still pond until the following summer, when the water dried up and I gave them away. The pond was about 3 feet deep, with a muddy bottom.

PLANTS.—Smart weeds and grasses grow in the pond.

ENEMIES.—Perch and bull-frogs inhabit the pond, but no turtles.

FOOD.—The carp fed on insects and mud. Very little care was taken of them.

GROWTH.—The 5 that I gave away in the summer of 1881 then weighed about $3\frac{1}{2}$ pounds each.

396. *Statement of J. M. Brooks, Waterford, Marshall Co., Miss., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 25 leather carp about 3 years ago, and have kept them in a small pond with muddy bottom. It is supplied only by rain-fall.

PLANTS.—It contains a water lily with large round leaves, commonly called "wampapin," in the Mississippi Valley.

ENEMIES.—There are also perch and frogs in the pond. I have never fed the carp.

GROWTH.—I still have all but 3, and they are large, probably from 5 to 6 pounds in weight.

REPRODUCTION.—The young are all in the pond, but I cannot tell their weight or number.

397. *Statement of Eugene Carleton, Decatur, Newton Co., Miss., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The carp which I received early in 1879 I distributed to J. B. Gaines, J. L. Hodge, and G. M. Gallaspy, none of whom have I heard from except Mr. Gallaspy, who makes a report for himself.

398. *Statement of G. M. Gallaspy, Decatur, Newton Co., Miss., July* 31, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp November 16, 1879. My pond covers ½ an acre, is 4 feet deep, slopes back gradually, and has a muddy bottom. It is fed by a stream 6 inches wide by 2 inches deep, but which in dry time ceases to flow.

PLANTS.—The pond contains wire-grass and reeds.

ENEMIES.—There are no other fish, but there are frogs, and I occasionally see a small turtle.

FOOD.—I give corn-bread once or twice a day.

GROWTH.—The 2 carp I have left would weigh about 4 pounds apiece. I have never seen any young.

DIFFICULTIES.—The greatest difficulty is by the theft of negroes. I had some carp in the pond last year that by this time would have weighed 10 pounds, as they were growing very fast.

399. *Statement of J. W. Guthrie, Newton, Newton Co., Miss., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The carp received 2 years ago I put in a pond covering ¼ of an acre, 2½ feet deep, with a black, muddy bottom. It is fed by several mall springs, which keep it full.

PLANTS.—There are all kinds of water grasses native to the South.

ENEMIES.—There are some perch and minnows, water-terrapins, and frogs.

FOOD.—I give them bread once a day.

REPRODUCTION.—They have produced young too numerous to mention. There are hundreds of them from 2 to 2½ inches long and smaller. The old ones got away during the freshet last spring. They were about a foot in length when the dam broke.

400. *Statement of T. F. Pettus, Newton, Newton Co., Miss., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received a dozen carp December 24, 1881. My pond is 30 by 50 feet and contains stagnant water. It also contains water grasses.

ENEMIES.—There are no enemies except frogs.

FOOD.—I give them corn 2 or 3 times a week.

GROWTH.—At 6 months old they were about 12 inches long. They grew very rapidly.

REPRODUCTION.—They were multiplying very rapidly, when the pond overflowed about 6 months after receiving them.

401. *Statement of Mrs. A. B. Watts, Newton, Newton Co., Miss., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received 30 carp, December 24, 1880, and 30 more in November, 1881. My pond has a sandy bottom, is 100 by 160 feet, with a depth of from ½ foot to 10 feet. It is fed by a spring. The temperature keeps at about 65°. It seems particularly adapted to carp.

PLANTS AND ENEMIES.—It contains bulrushes, mosses, and grasses. There are frogs in abundance, a few silversides, and occasionally a turtle.

FOOD.—We give them scraps from the table daily.

GROWTH.—The old ones weighed about 10 pounds when the pond was destroyed by the cyclone last spring.

REPRODUCTION.—There was a very great quantity of young which all escaped into the creek below.

MISCELLANEOUS.—They were no trouble. Their care was a pleasure. They are of great value to people living remote from market. We are enlarging the pond for another lot.

402. *Statement of Monroe Pointer, Como Depot, Panola Co., Miss., Aug.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp February 20, 1881, and 40 in the spring and fall of 1882. My pond is 50 by 50 feet, 10 feet deep, has a muddy bottom, and supplied with rain water. It contains no plants.

ENEMIES.—It contains a few perch.

FOOD.—Three times a week I give them wheat and corn ground.

GROWTH.—I transferred the old ones, which weighed 7 pounds each, to Dr Caruthers, who has a fine pond 6 miles west of Como Depot.

REPRODUCTION.—They have produced any quantity of young, which are now of various sizes and weights.

403. *Statement of John Ohleyer, Brandon, Rankin Co., Miss., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—I received 11 carp nearly 3 years ago, and have had a few twice since. My pond is 140 feet long, from 12 to 30 feet wide, and 5 feet deep, with clay bottom. It is supplied by a small spring, which gets very low in summer. It never freezes.

PLANTS.—The pond is surrounded by water grass, Bermuda grass, and willow bushes.

ENEMIES.—There are no other fish, but a few turtles, some snakes, and a great many frogs.

FOOD.—I give them bread, crackers, and some vegetables once or twice a week.

GROWTH AND REPRODUCTION.—I caught some a few months ago that weighed about a pound. The young ones are very small.

404. *Statement of W. M. Thornton, Lake, Scott Co., Miss., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp November 23, 1880. My pond covers ¾ of an acre, is 8 feet deep, and has a very muddy bottom. It is dependent on rain for water, which gets quite warm in summer—65° to 75°.

PLANTS.—It contains water-lilies, wild rice, and water grasses.

ENEMIES.—There are sun-fish, craw-fish, frogs, toads, but no turtles. I fear I have but few spawn this season on account of the craw-fish.

FOOD.—I give them daily corn-bread, soft corn, and vegetable refuse from the garden.

GROWTH.—There are 15 from 20 to 25 inches long, which would weigh from 7 to 10 pounds each.

REPRODUCTION.—There were hundreds, and may be thousands, of young produced in 1882, which are now from 7 to 10 inches long. In May we ate some of them fried and they were excellent.

DIFFICULTIES.—The only difficulty is the craw-fish.

405. *Statement of F. M. Norfleet, Senatobia, Tate Co., Miss., Nov.* 24, 1883.

DISPOSITION OF CARP RECEIVED.—About January 1, 1881, I received 19 carp. My pond is about 40 by 60 yards, with a depth of from 2 to 4 feet, and a bottom covered with a muddy black deposit and washings from the horse lot. The rainfall off of about 4 or 5 acres supplies the pond with water, which is warm, except in midwinter.

PLANTS.—The pond contains a few weeds and some brush around the edges.

ENEMIES.—There are perch, cat, and bull-frogs. Occasionally a turtle is seen. The carp suffer from the depredations of other fish, which it seems almost impossible to keep out.

FOOD.—They get the washings from the feeding places for horses and hogs.

GROWTH.—I regard the carp as the most rapid growers among pond-fish. The old ones will weigh from 5 to 7 pounds. I caught one a few days ago which weighed 6 pounds. Less than half the original lot are still left.

REPRODUCTION.—I can discover no young. They must be very sluggish and careless in the protection of their young.

EDIBLE QUALITIES.—I regard the carp as being the best pond fish in existence. I have eaten them and find them to be as good as any.

406. *Statement of Wm. Laney, Tyro, Tate Co., Miss., July* 22, 1882.

GROWTH.—The carp received in December, 1881, and which then weighed hardly 1 ounce, now average 14 inches in length and 6 pounds in weight. I find the carp all that is claimed for them. My efforts in their culture have been very successful.

407. *Statement of Lowrey & Berry, Blue Mountain, Tippah Co., Miss., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—We received 20 carp in the fall of 1880, 20 more in 1881, and 19 in 1882. Our pond is 60 by 120 feet, 3 feet in depth, has a bottom partially sand and partly soft mud. At present it is fed by a 2-inch stream of water, which stands at 75°. There are no plants in it.

ENEMIES.—There are a few small perch, a few frogs, but no turtles nor snakes.

FOOD.—We give them table scraps irregularly.

GROWTH.—We still have 3 of the first lot, which will weigh 6 pounds apiece, 10 of the second lot, and all of the last. Two-year-old carp weigh 4½ pounds. We have not seen any young yet.

DIFFICULTIES.—The first trouble was with other fish, which was partly obviated by moving the carp to a new pond after all but 4 had been destroyed. The new pond broke once and let out all of the second supply, a part of which was lost.

408. *Statement of L. Rogan, Ripley, Tippah Co., Miss., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp in the winter of 1881–'82, and gave them to another gentleman, who had a pond. People here report their culture a success in ponds supplied both by rains and running water.

409. *Statement of E. F. Raworth, Vicksburg, Warren Co., Miss., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received some carp in April, 1881. The pond is 100 feet long, 50 feet wide, 70 feet deep, and has a muddy bottom. It is supplied by rain-water. It contains no plants.

ENEMIES.—It contains catfish, white perch, bank perch, frogs, and turtles.

FOOD.—When first received I fed them on crackers, but not lately.

GROWTH.—The largest one caught weighed 4½ pounds. They vary from 2 to 4 pounds.

REPRODUCTION.—The young are small. They seem to be very prolific, but I cannot approximate the number.

EDIBLE QUALITIES.—I think it very likely that the muddy bottom of the pond causes the fish to be so indifferent for eating.

410. *Statement of W. L. Brandon, Fort Adams, Wilkinson Co., Miss., Aug.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—I received 25 carp in February, 1881. My hatching pond covers ½ an acre, has a muddy bottom, and shoals from 4 to 1 foot. It is supplied with rain, but being shaded, the temperature is between 80° and 90°.

PLANTS.—There are no grasses. I have planted wild rice, but the carp rooted it all out.

ENEMIES.—I exclude all fish, frogs, and turtles from the hatchery.

FOOD.—I gave them hominy left from the table, and sometimes lettuce and cabbage.

GROWTH.—The cyclone of April 28 damaged me many thousand dollars, and I mourn the loss of my carp more than anything else. The 4 I got out were about 18 inches long.

DIFFICULTIES FROM POISONING.—The cyclone of April 21 killed or caused the death of all but 4 of the carp in my hatchery. The hail thrashed the leaves off the pecan trees near the pond, into which they fell in large quantities, the tannin poisoning the water so that all died but the 4. The pecan leaves turned the water in the pond as black as ink. The fish were 3 years old, and when I saw them swimming on the surface of the water I thought they were spawning. When they began to die I immediately seined the pond, but only got out 4 alive. The carp in my pond were of the mirror and leather varieties. All the mirror carp were dead.

TAMENESS.—I did not get them so gentle as to eat out of my hand, but thought and cared for them continually. They were very lively and sportive. Please send another lot.

411. *Statement of Nath. Cropper, Woodville, Wilkinson Co., Miss., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in January, 1881. My pond is about 40 feet in diameter, 3 feet deep, has a muddy bottom, and is supplied by the surface drainage of one acre. The pond being too small. I will soon transfer the carp to one that I am preparing, with muddy bottom, grasses, &c.

ENEMIES.—There are no other fish in the pond.

FOOD.—I give them corn-bread and vegetables about twice a week.

GROWTH.—The 6 that remain weigh about 15 pounds each.

REPRODUCTION.—I have lost a good many young by overflow of pond. Those left are of this spring's hatching and about 6 inches long.
DIFFICULTIES.—Three carp died in one day last summer, the cause of which I cannot ascertain.

412. *Statement of E. L. McGehee, M. D., Woodville, Wilkinson Co., Miss., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp in January, 1880, and in January, 1883. My pond covers ½ an acre, is 5 feet deep, has a grassy and muddy bottom. It is fed by rain-water, and the temperature varies. In the part that is deep and shaded the water is cool.
PLANTS AND ENEMIES.—It contains crab-grass, but neither frogs, turtles, nor other fish than carp.
GROWTH.—They are now 18 inches long and weigh from 4 to 5 pounds each.
REPRODUCTION.—They have produced hundreds of young, which are from 6 to 8 inches long.
MISCELLANEOUS.—I have not fed them, but they are a hardy and rapid growing fish. I find difficulty in catching them, as I do not like to draw the seine.

413. *Statement of A. M. Gaillard, Water Valley, Yalobusha Co., Miss., Apr.* 10, 1882.

GROWTH.—About 12 months ago I put 18 carp in my pond, measuring from 3 to 5 inches in length. We caught 1 last Monday which was 17 inches long and weighed 3 pounds. The value of these fish can be readily estimated when it is known that they have not been fed a dozen times in 12 months.

MISSOURI.

414. *Statement of T. Holt, Holt's Summit, Callaway Co., Mo., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—In December, 1880, I received 21 carp. The pond in which I have kept them is 70 feet long, 40 feet broad, and 10 feet deep. Its bed is composed of yellow clay. A good quantity of moderately cool water flows through it.
PLANTS AND ENEMIES.—It has grasses growing in it, and contains one catfish and plenty of craw-fish.
FOOD.—I feed the carp with bread—not very often, only in the spring-time.
GROWTH AND REPRODUCTION.—I have 19 of the original lot left. They weigh 5 pounds apiece. I have not seen any young ones yet.
DIFFICULTIES.—My principal difficulty is in catching them. They will not bite at a hook, and I cannot catch many with a trammel-net.

415. *Statement of Paris A. Dougherty, Myers, Howard Co., Mo., Aug.* 24, 1883.

DISPOSITION OF CARP RECEIVED.—The water of the pond in which the carp were kept was so muddy that I could not see them. I have now made another pond, 80 yards long, 50 yards wide, and 12 feet deep, in addition to my old one.
GROWTH.—I tried to catch some of them with a hook, but they would not bite. So I sent to Saint Louis and got a seine, and dragged out one about 18 inches long, the most beautiful fish I ever saw. From the growth which they have made I think I have got the richest thing I ever struck.
REPRODUCTION.—I now see schools of young fish all over my pond. I have a screen of fine wire in the drain to keep them from escaping. I want to try a plan of my own by taking the young out of the pond they hatched in and putting them into my new pond, so that they will grow up there and all come to market together. I will still keep the old ones in their place to produce new crops, which I will remove in their turn to the growing-pond.
DISPOSITION OF YOUNG.—I think that in 2 years from now I can sell $500 worth of fish.

416. *Statement of J. P. Ozias, Centre View, Johnson Co., Mo., July* 30, 1882.

DISPOSITION OF CARP.—Early in June I paid to a gentleman who received carp from you $5 for a pair of scale carp 2 years old. I placed them in a pond fed by a continual stream of spring water. I also obtained in the same way 7 mirror carp, for which I paid $15. These were put in a reservoir, which is supplied with spring water by means of an air-pump.
PLANTS.—Grass grows in the pond and around the edges of the reservoir, where I planted it.

REPRODUCTION.—There are from 1,000 to 2,000 young scale carp from $1\frac{1}{2}$ to 2 inches long in the pond. I have been very successful with the carp in this pond. Though the mirror carp deposited thousands of eggs on the grass, weeds, &c., which I tied in the center of the reservoir, none of those have hatched.

417. *Statement of Amos Markey, Warrensburg, Johnson Co., Mo., Aug.* 25, 1883.

DISPOSITION OF CARP RECEIVED.—In December, 1880, I received 20 carp. I kept them in a pond which covers an acre, has a muddy bottom, and is 8 feet deep when full. It is filled from the rain only.

PLANTS AND ENEMIES.—It contains flags. There are no other fish in it now.

FOOD.—I did not feed them at all.

GROWTH.—In June, 1882, I drained my pond to get the wild fish out, and as the pond did not get full again, last winter all the carp died. They then weighed from 3 to 4 pounds. If I had not drained my pond I would have had plenty of water, so that the fish could have wintered through. I made a big pond last spring, which covers 4 acres of ground, and is full of water from 1 foot to 5 feet deep.

418. *Statement of Selden P. Williams, Warrensburg, Johnson Co., Mo., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in November, 1880. I put them in a pond covering about $\frac{1}{2}$ of an acre, with a depth of from 3 to 5 feet, and a muddy bottom. The pond is supplied by rain running off of a timothy and clover meadow.

PLANTS.—It contains no water plants, but is bordered with timothy.

ENEMIES.—There are very few frogs or turtles in it. Three little catfish were put in the same fall that the carp were, by the children, who did not know what the result would be. These, I think, prevented what would have been a good increase last year (1882).

FOOD.—I feed them with wheat, wheat-bran, shorts, and meal; also seeds of various kinds, especially sunflower seed.

GROWTH.—The fish were very small when I received them—about 3 to $3\frac{1}{2}$ inches long. In the spring of 1882 they weighed 4 pounds, and in the fall of that year they were perfectly healthy. They were very lively and sportive and some of the prettiest fish I ever saw.

REPRODUCTION.—They produced some young, but I cannot tell how many.

DIFFICULTIES.—The winter of 1882 closed in with a good body of water in the pond. The ice formed 6 inches thick, after which there was a heavy fall of snow, followed by a long cold spell. Then came a sudden thaw and heavy rain, flooding the pond and raising and breaking up the ice. There came next a light freeze, and again a thaw, after which all the original carp floated to the top dead, together with some small carp and catfish. This cleaned the pond out and left it without fish. I am satisfied that their death was caused by the flooding with comparatively warm water, breaking up the ice and throwing them out of their bed.

Others getting carp at the same time as myself lost theirs, except one whose pond was fed by a spring as well as rain. I shall in future prevent the flooding of the pond in winter. I have applied for more carp.

419. *Statement of O. P. Johnson, Paris Springs, Lawrence Co., Mo., May* 6, 1882.

GROWTH.—The carp received in December, 1881, have made a splendid growth, the largest by actual weight being $4\frac{1}{2}$ ounces and measuring about 7 inches in length.

420. *Statement of A. S. Ray, La Plata, Macon Co., Mo., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—On the 16th of October, 1881, I received 25 carp, and have had none since. I put them in a pond made expressly for them, covering 1 acre, and receiving the drainage from about 4 acres of meadow land. It is from 3 to 7 feet deep, and was dug in clay soil, but has a muddy bottom. The temperature of its water is now from 74° to 76°.

PLANTS.—Water grass, wild rice, and flags grow in the pond.

ENEMIES.—It contains no fish. The turtles I keep shut out. There are bull-frogs in it, and some water lizards, which I cannot keep out.

FOOD.—I give the carp baker's bread, oats, and corn-crackers every day.

GROWTH.—They were from 2 to 3 inches in length when I got them, in 1881, and last March, when the ice broke up, they were found to be from 12 to 17 inches long.

DIFFICULTIES.—They all froze to death last winter. The water was 7 feet deep under the ice all winter, and I have no idea what caused them to freeze. I will try some more this fall from the State hatchery. My neighbors got some carp at the same time that I did, and all but one of them lost all they had. He lost 6, but the balance of his are doing finely.

421. *Statement of William H. Terrell, Macon City, Macon Co., Mo., Mar.* 12, 1883.

DISPOSITION OF CARP RECEIVED.—I placed the 27 carp received June 14, 1881, in a pond rectangular in shape, 105 by 155 feet, with an average depth of 7½ feet, maximum depth of 12½ feet, and a muddy bottom. The water is as clear as though it issued from a spring. No stock are permitted to go to it, nor any sediment allowed to be washed into it. It is entirely cut off from the stream, a channel being cut around it. This pond was built at an expense of nearly $200.

ENEMIES.—There are two other kinds of fish in the pond, namely, common perch or sun-fish and the common chub. The latter, however, got into the pond by accident. These fish subsequently died.

GROWTH.—The carp placed in the pond were of two sizes. To-day I measured one of the larger size in the presence of witnesses. Length of head, 4½ inches; tail, 3 inches; girth, 12½ inches; and its entire length, 19½ inches. Its width was 5½ inches, and it weighed a fraction over 5 pounds.

DIFFICULTIES.—When the ice thawed 26 of the 27 carp came to the surface dead. The cold winter seems to have been too severe for them, and I fear that this settles the question whether carp can be raised in this latitude, as I gave them a fair show in my pond.

MISCELLANEOUS.—The carp is a true sucker-fish, and more slender than our buffalo fish, which, with the exception of its color, it resembles very much.

422. *Statement of Peter Joseph Schmidt, Tipton, Moniteau Co., Mo., Oct.* 13, 1882.

GROWTH.—The carp that I received last January I placed in a pond purposely constructed for them. Some of them are now 13 inches long and from about 3½ to 4 inches in diameter.

423. *Statement of Samuel R. Snider, Monroe City, Monroe Co., Mo., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—In December, 1881, I received 20 fish. The pond in which I have kept them covers about an acre and is from 3 to 10 feet deep. The bottom is composed of clay and black soil.

PLANTS AND ENEMIES.—It contains flags and water grass. There are catfish and sun-fish, frogs, and a few turtles in it.

GROWTH.—The carp are from 19 to 20 inches long and weigh from 4 to 5 pounds. I got some by their being accidentally washed out from the pond in an overflow. They have made a rapid growth, and I think them the best fish for our waters which we have.

424. *Statement of A. B. Warner, Monroe City, Monroe Co., Mo., Aug.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—I was unsuccessful in raising any carp whatever from the 20 you gave me. The winter of 1881 was so extremely cold here that it was impossible for them to live in the ½ acre of water I placed them in. The cold froze 5 feet of water solid that winter, and killed the fish in the muddy bottom of the pond. I should like some more.

425. *Statement of G. W. Varnum, M. D., Montgomery City, Montgomery Co., Mo., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 10 carp in the spring of 1880, and put them in a pond covering an acre and from 4 to 6 feet deep. The bottom is of clay. It only overflows after heavy rains. The temperature of the water is about 80° on top and 60° at the bottom.

PLANTS.—The pond contains *Nymphæa odorata*, *Sagittaria*, and a species of *Equisetacea*.

ENEMIES.—There are in it some black perch, silversides, a few frogs, and one turtle. I can't keep them out.

FOOD.—I feed the carp with wheat-bread and corn once and sometimes twice a day. They come to the edge of the water when called.

GROWTH AND REPRODUCTION.—I think that I have 8 left, as I have seen as many as 7 at a time this spring. They grow very rapidly and are now from 16 to 18 inches long. I don't know how many young they have produced, as they keep the pond so muddy. They root up my pond-lilies. I think they spawned this spring, as they acted as other fish do when spawning. The one killed had eggs in it. I caught a carp June, 1881, which was 13¾ inches long.

426. *Statement of I. A. Bell, Racine, Newton Co., Mo., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—I received 8 carp two years ago, but lost them in a freshet.

427. *Statement of C. C. Jackson, Hughesville, Pettis Co., Mo., Apr.* 30, 1882.

GROWTH.—I put 2 carp, each 3½ inches long and exceedingly slim, in my pond last season. One caught in a seine last Saturday proved to be 20 inches long from the tip of its tail to the end of its nose, and 24 inches long taking in the curvature of its back. Its thickness from the middle of the back to the middle of the belly was 7½ inches. Its width straight through the thickest part of the body was 4 inches; its weight, 4 1/16 pounds; and the scales on it were as large as a 5-cent piece. The growth of this carp is truly wonderful. The time is near at hand when everybody will have a carp pond the same as they do a cow and hog pen.

428. *Steatment of Oscar Reid, Ferguson, Saint Louis Co., Mo., Aug.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—About 3 years ago I received 16 carp, and since then I have received from Saint Louis 16 more. The pond in which I have kept them is 180 feet long and 80 feet wide, and has an average depth of 4 feet. The water rises from the bottom, which is muddy.

PLANTS.—Water-lilies grow in it.

ENEMIES.—The pond also contains sun-fish, crappies, and turtles.

FOOD AND GROWTH.—I do not fed the carp, and do not know how many there are left. They weigh about 10 pounds on the scales.

REPRODUCTION.—I do not know that there are any young, but think there may be some.

DIFFICULTIES.—I have had no difficulty in their care. My only trouble is to catch them.

429. *Statement of George W. Campbell,* 108 *Locust street, Saint Louis, Mo., Nov.* 18, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1879, I received 20 scale carp not over 1 inch in length, which I placed in my pond. This is in size about 50 by 150 feet, has a muddy bottom, and slopes gradually from one end to a depth of about 6 feet at the other. No water flows out of it except once or twice a year during very heavy rains; then I let it out gradually through an 8-inch pipe, so that the water is usually about the same depth.

PLANTS AND ENEMIES.—There are no enemies except a few catfish and sun-fish. It contains no plants nor grasses, but is sodded with grass all around the banks.

FOOD.—During the 4 years they have had no care except that perhaps 3 or 4 times during each summer's drought I fed them with corn-meal mixed with water and made stiff.

GROWTH.—To-day I secured 4 men, who made a haul with a seine and landed 7 carp, 6 of which averaged about 3 pounds, and the seventh one weighed, I guess, 1 pound. The latter was evidently not over a year old. The others have had but 3 summers' growth, and have made an increase in weight of exactly 1 pound each every season, which, when we consider that they have had no care, may be regarded good, and proves them to be a very profitable species for propagation.

REPRODUCTION.—I do not know how many young they have produced, but they seem to have done well. I have seen no young over 3 inches long. I think they did not do well the first year, as there was no brush in the water to protect them.

EDIBLE QUALITIES.—Three families, including my own, have to-day, for the first time, tested carp upon the table. None of us claim to be epicures, but we have often tested the qualities of our black bass, crappie, channel cat, and the buffalo of the Mississippi, and, in our judgment, the carp compare favorably only with the latter; perhaps we may say, only with the 2 last named.

DIFFICULTIES.—I have had no difficulties, unless it has been that the catfish have fed to some extent upon the young.

430. *Statement of George Eckardt, Saint Louis, Saint Louis Co., Mo., Dec.* 8, 1882.

GROWTH.—I have carp 6 months old, from 4 to 14½ inches long, and in very fine condition.

431. *Statement of Dr. I. G. W. Steedman, Saint Louis, Saint Louis Co., Mo., Nov.* 27, 1882.

REPRODUCTION.—On draining our ponds in Forest Park, to our great surprise, we have found a bountiful supply of young carp. I suppose we have 20,000, at a rough estimate. They are beautiful specimens, averaging from 4 to 6 inches in length. In

a pond of 5 acres we found 400 young carp of 14 inches. If I had not put the parent fish in the pond with my own hands, I would have supposed they were dwarfed old fish, but the facts are absolute and true as stated above. Next season I have great confidence that we will produce vast numbers of young carp.

432. *Statement of E. Crockett, Marshall, Saline Co., Mo., Apr.* 11, 1883.

CARP TAKEN FROM MISSOURI RIVER.—Large numbers of young carp, a foot or more in length, are being taken from the Missouri River near here, and with other fish are sold in the markets at this place. One of the largest weighed 2 pounds.

433. *Statement of Samuel McClelland, Salt Springs, Saline Co., Mo., Jan.* 18, 1883.

GROWTH.—The carp I received in June, 1880, have increased in size and multiplied in number beyond all my expectations. The original carp are now over 3 feet long. On one occasion I caught one of these large fish, but it broke the line and escaped.

REPRODUCTION.—The young of the fall of 1880, when my carp first spawned, are 27 inches long and weigh 10 pounds each. The following summer's young now measure from 12 to 18 inches in length and weigh from 1 to 5 pounds. Last summer we caught with the hook all the carp we wanted for use. The fish taken were in but one instance of the second hatch, weighing about a pound in the spring and 5 pounds in the fall. In summer millions of little fish can be seen in the water.

MISCELLANEOUS.—In regard to spawning, I believe my carp are laying eggs every warm day in the year, yet I have never found an egg, except in the fish which are caught, and they are generally full. My ponds now cover 8 acres, to which I will add 2 more in the spring.

HOW TO CATCH CARP.—We have caught but one of the large ones. After we got it out of the water it broke the line and got away. We caught but one of the first lot in a net; it measured as before stated. We caught with the hook all we wanted for use last summer. Our catch was invariably of the second hatch, commencing in the spring at 1 pound and increasing by degrees till in the fall they weighed as much as 5 pounds. We often tried to seine them out, but only succeeded in catching a few of the same size we caught with the hooks. Often larger ones would strike the net with great force, but when you came to shore they were not in it. I believe they go down in the mud and the head-line drags over them.

434. *Statement of Samuel McClelland, Salt Springs, Saline Co., Mo., Sept.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—I received 8 carp from the United States Fish Commission June 28, 1880, and bought 4 more from Mr. J. C. Keithley. I have since received 10 scale carp from Saint Joseph. My ponds are fed by springs within the banks, which produce 18 gallons per minute. There are 8 acres of surface water, the depth varying from 6 inches to 8 feet. The bottom is peat and black soil. Very little water passes out of the ponds, what they lose being mostly evaporated, and it is not cold, but hot as the sun can make it.

PLANTS.—The ponds contain all kinds of plants and grasses I have ever seen, and some I never saw before, but I only know the names of the flag or cat-tail, lily, and arrow plant. Another plant I call water-clover came this summer, and the ponds are covered with it. The little plant I send you is abundant, and the fish eat it as a cow eats clover. It has increased so fast that the ponds are covered with it. The leaves spread out on the water and the roots hang down. The fish when feeding on it open their mouths wide and push their lips up through them, sucking down all that is within the circle. I have seen dozens of them feeding on it at a time. They do it so quietly that it scarcely makes a ripple. The plant was so thick that the fish could not see me. I was so close I could have spit in their mouths when their lips came through, so there can be no mistake about their eating it. I can see no seeds nor blossoms. How it increases or where it came from I do not know. [The specimen inclosed by Mr. McClelland has been identified by Mr. W. B. Conant, assistant botanist of the Department of Agriculture, as *Lemna polyrhiza* L. (duck-weed or duck's-meat). He says, "There are several species of *Lemna*. The flowers are produced from the margin of the frond and are very small and very obscure. This species is supposed not to flower at all in this country, but the specimen appears to have seeds, which, if true, would establish its flowering here. Possibly there may be some other species intermixed in the specimen. The mode of propagating is by budding from a cleft on the edge of the frond. This is one of the smaller flowering plants, and some species are among the smallest."—EDITOR.]

ENEMIES.—I am sorry to say the ponds contain mud-cat and sun-perch, crappie, hard-shell turtles, wild ducks, cranes, gulls, night-herons, king-fishers, snakes, frogs, &c. I have found no carp in ducks nor turtles, but have taken 9 from the stomach of one night-heron.

FOOD.—I have fed the carp on corn, oats, wheat, screenings, and boiled potatoes; but since I enlarged the ponds the carp root for a living, staying at the bottom. They refuse to come to the surface for the most tempting morsel. Last year I could bring them to the surface by food floating on the water. This year nothing will bring them up. When I feed them, oats and millet seem to be their choice.

GROWTH AND HABITS.—To the best of my knowledge there are 8 or 10 of the original number, and I feel sure they were all well a year ago. The old ones are over 3 feet long, I think. For days, and sometimes weeks, the water is still and comparatively clear; you would think no living thing was in it; then all at once there is a bubbling, then wave after wave appears and the water fairly boils and foams, being moved by the fish below. Murky clouds rise to the surface, and soon the whole pond is like as if a hog had wallowed there. Then comes the calm, and the water becomes clear again. Such are the carp. They stay either in some clear, shady spot or in the muddy water, leaving us to imagine their size and numbers.

REPRODUCTION.—How many young have they produced? Oh, heavens! How many sands are there on the sea-shore? They breed from early spring to late fall—millions of them. They first spawned when two years old and were 27 inches long, weighing 15 pounds. It is just impossible to catch the old ones with the seines, and we have no hook that will hold them. The young weigh from a mite up to 15 pounds. I stocked a new pond one year ago, and the young averaged a pound at least last spring. We caught 61 at one draw. I suppose they were last fall's hatch. When very young they may be seen upon the margin of the pond in shallow water by thousands, acting very much like any other little fish. By the time they are an inch long they disappear and another lot of small fry takes their places. When they have gone to the bottom it is seldom that they reappear unless brought out by violence or starvation.

SALES.—I have sold lots of the young for stocking other men's ponds. They come 200 miles to get them. I have sold none for food, as they are hard to catch. When I have finished making my ponds and put the fish on the market I expect to make more money than can be made by a farm of 400 acres of the best land in Missouri.

EDIBLE QUALITIES.—Have we eaten any carp? Yes, we used them all last summer and gave a mess to all our friends and neighbors. All with one voice say they are the best fish they ever did eat, and so say I. We cook them as you please. They are good any way.

FUNGUS AND OTHER DIFFICULTIES.—Last spring I saw a few little ones having a scurf or a growth of some kind extending from the nose back until the whole body appeared swollen or musty-looking. They became sick and swam near the top. All I saw, which were 6 or 8, died. I do not know what was the matter or the cause of it. The most serious difficulty has been to keep down their many enemies. When I drain the ponds I will make clean work of it, and not till then can I make a full and fair statement of my success in raising carp. But as it is I am well satisfied and the whole country is surprised.

435. *Statement of J. C. Keithley, Shackleford, Saline Co., Mo., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 4 mirror carp June 24, 1880. Eight were allotted to me, but 4 I gave in payment for their transportation. I afterwards received 10 scale carp. I have kept them in a pond which covers ¾ of an acre, is from 2 to 6 feet deep, and has partly clay and partly rich soil for a bottom. It is fed by a perennial spring flowing at the rate of 2 gallons per minute. The temperature of the water at the spring is 54° Fahr.

PLANTS AND ENEMIES.—It contains water-cresses, flags, water grasses, &c. There are no fish in it besides the carp. Water-frogs and toads spawn in it in the spring of the year.

FOOD.—I give them no food at present, but will give cabbage, crushed corn, and wheat screenings to them when the pond is well filled.

GROWTH.—I have 3 of my original carp left. I lost one soon after putting them in the pond. They now weigh about 8 or 10 pounds. When I last weighed them, which was at the end of the first year, they weighed 2¾ pounds.

REPRODUCTION.—I am not able to say how many young have been produced, as the water is too muddy to count them. They are from 8 to 10 inches long. I think they were spawned last year. My first 3 carp were all males. We have not used any of the young ones, but will commence eating them next year.

MISCELLANEOUS.—This fall I expect to make a pond of 3 acres, which I should like to stock with leather carp exclusively, if you can furnish them to me when it is ready. It will be on black alluvial soil, where grasses and water-cresses will grow luxuriantly, and it will be fed by three good permanent springs.

SUCCESS OF OTHERS IN RAISING CARP.—I believe that Mr. McClelland and I were the first to receive carp in this part of the State. Mr. McClelland has succeeded beyond all expectations. He has sent numbers to other States and counties for breeding

purposes. I think we have the very best of soil for raising the German carp, and also the best of water, as we exclude the rain-water and depend on soft spring water to supply our ponds.

436. *Statement of William A. Reid, Shelbina, Shelby Co., Mo., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in November, 1880. Eight more were given to me in November, 1882. I had an old pond of some years' standing. In August, 1879, I drained it thoroughly, and enlarged it, scraping out all the mud down to the solid clay, so as to make it about 2 feet deeper. After being finished, it was exposed to the hot summer sun for at least two months (August and September) before there was any water in it. It is now about 200 feet long, 60 feet wide, and from 4 to 6 feet deep.

PLANTS.—Smartweed and other wild grasses grow around the edges.

ENEMIES.—In November, 1880, I put in the 20 carp; in the following August I dragged the pond with a seine and found no carp, but found minnows by the thousand, some perch, and 1 or 2 catfish. Last summer (1882) there were any quantity of perch, and I caught 3 or 4 catfish, but no minnows whatever. There seemed to be thousands of perch of all sizes. I caught a number of messes of full-grown ones. This summer I have been unable to see a single perch, but there are a good many small catfish, besides turtles and frogs in abundance. Now, the wonder to me is how these various kinds of fish got into the pond. It had at no time any connection with water below it, and all the water that went into it was what fell in my grass lot above the pond. It is just impossible that they got into it from below, and of course there was no place above for them to come from. How did all that multitude of perch that was there last summer and fall disappear so suddenly? I have come to the conclusion that minnows, perch, and catfish cannot be kept out of a pond here unless it is arched over and thoroughly cemented so that a chigger cannot get in. I was extremely careful and thought I had a dead-sure thing against other fish. Can you offer any explanation?

FOOD.—I fed the carp for some time with bread and cabbage, but finally quit feeding, because I thought all were dead.

437. *Statement of Jesse Jennings, Pikcton, Stoddard Co., Mo., Feb.* 18, 1884.

GROWTH.—The carp which I received in November, 1881, now weigh nearly 12 pounds apiece. I expect them to increase during the coming summer.

438. *Statement of A. Hubbs, Mounds, Vernon Co., Mo., Dec.* 1, 1882.

DISPOSITION OF CARP RECEIVED.—I planted my carp last fall in a newly constructed pond, supplied with water from fields. No other fish had been placed in it.

FOOD.—Last winter being an open one here, the carp had plenty to eat.

GROWTH AND REPRODUCTION.—August 14, 1882, my original carp were from 12 to 16 inches long, and the numerous young in the pond about the size of my old fish when planted. Now the original carp are from 2 to 2½ feet long, and the young from 1 to 10 inches.

NEBRASKA.

439. *Statement of B. E. B. Kennedy, Omaha, Douglas Co., Nebr., Apr.* 14, 1883.

FUNGUS.—On visiting our fisheries yesterday I find that many of the young carp are affected with a kind of parasite or fungus, which proves fatal. With some it appears on the back, some will have a strip nearly around the body, and some about the fins and tail. This fungus is easily removed, and the skin or flesh under it has the appearance as if the spot had been blistered. Several hundred have already died, and many more are similarly situated, and, unless there is some remedy administered, all will be likely to die. We have separated the affected ones from the others, hoping to stay the spread of the disease, if it is one. Those that show no fungus appear all right and take food readily.

NOTE BY PROFESSOR BAIRD ON FUNGUS.—Where the carp are taken from their winter quarters for our spring shipments there seems to be a general tendency to the development of the fungus. It is probably due to the abrasions produced in handling, the development of fungus taking place in consequence of the emaciated condition of the fish after wintering. We do not find this diseased condition in the fish taken out of the ponds for the fall and winter shipments.

I am at a loss what remedy to suggest. It is possible that you may be able to

destroy it by immersing the fish for a few seconds in a brine, of course allowing them to remain but a short time, and repeating the bath several times at intervals sufficient to allow the fish to recuperate from the shock of the operation.

440. *Statement of B. E. B. Kennedy, Omaha, Douglas Co., Nebr., Oct.* 23, 1883.

GROWTH.—Our carp at the fisheries which we received in December, 1881, have grown well, but did not spawn this year. They will be 3 years old next summer. Some of these two-year-old carp weigh 3 or 4 pounds. I am more than ever satisfied that this is the fish for Nebraska.

441. *Statement of J. Burrows, Mellroy, Gage Co., Nebr., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The carp received from you and placed in my pond did not, in my opinion, survive the first winter. I went personally to Saint Joseph, Mo. (a distance of 130 miles), to obtain them. On my return I was compelled to remain over-night at a place where there was no hotel. That night the weather turned intensely cold. I set the can containing the carp as near as I deemed prudent to a well-heated coal-stove at the railroad station. By morning the room had become very cold and crystals of ice had formed through the water in the can, with a thin coating of ice on its surface. I added water of a higher temperature, but was careful not to make a too sudden or great change. I was able to place them in the pond that afternoon at 4 o'clock. They were all alive (20), but I thought they seemed dull. Seeing nothing of them the next spring and summer, and having another pond to which I could remove them, I drained the pond carefully, but found no carp, nor any remains of any. My belief is that they did not live through the winter.

ENEMIES.—My pond had not at that time been invaded by predatory vermin such as turtles and bass, but these occupy it now to such an extent that the attempt to stock it with carp would be futile. I know of no way in which I can keep out bass without an outlay far beyond my means. They run in in times of high water, and in our rainy season the rise is frequently so sudden and great that no barrier, outside of an appropriation in the river and harbor bill, would be of any avail.

The loss of my carp caused me great regret. I would be glad now to make another attempt at their propagation, were I not satisfied that the obstacles which I cannot overcome make failure inevitable.

NEW HAMPSHIRE.

442. *Statement of Stillman S. Hutchinson, Milford, Hillsborough Co., N. H., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp in November, 1880, and some subsequently. My pond covers ½ acre, is 4 feet deep, and has a clayey bottom. It is fed by springs, and there is very little waste water. The temperature is about 50° to 60° in midsummer.

PLANTS.—It contains white-water lilies and a dense growth of grass.

ENEMIES.—It contains frogs only. Some of the carp were caught last winter by a mink.

FOOD.—I have fed them from 5 to 3 times a week on wheat, bran, boiled potatoes, lettuce, &c.

GROWTH.—I have seen 6 of the old carp this season, and should judge they would weigh 2½ pounds each. They are about 15 inches long.

REPRODUCTION.—They have produced a great number of young, which are from 2 to 5 inches long. I have no means of accurately estimating the number. I am very much pleased with them so far.

NEW JERSEY.

443. *Statement of Banner Thomas, Absecom, Atlantic Co., N. J., Nov.* 1, 1882.

GROWTH.—On New Year's eve a small stock of carp were placed in my pond, 1½ miles north of Absecom, N. J. They were little fingerlings, not one of them probably weighing over an ounce. This season I constructed 3 more ponds, and on Saturday I went down to transfer the carp to a larger pond, in order to vacate the first one for this season's supply, now about to be distributed. The transfer was in the presence of a large number of persons who had assembled for the purpose. The carp were measured, and the largest ones weighed. The smallest measured 17 inches in length, and the two largest 22 inches in length and weighed 7 pounds each. The age of these fish cannot be much, if any, over 15 months, and the most of this growth has been attained in the last 7 months.

444. *Statement of D. S. Blackman, Port Republic, Atlantic Co., N. J., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—My pond is a mill-pond supplied with water from a cedar swamp, and contains pond lilies, and no other fish or reptiles. I got 20 carp in December, 1881, and left them in the can until the pond embankments were finished. I put in some mud for them to imbed themselves in, but they all soon died. A fine lot from Washington, which reached me in the fall of 1882, I had to keep till December on account of a break in my mill-dam, which supplies water for the carp ponds. The cold set in very suddenly and severely and before I could again fill the pond with water they, to my sorrow and surprise, were frozen. I had the can warmly kept, too. I shed tears over their loss, and last fall I was given a few more very small ones, which also died, in spite of all I could do, seemingly because the can was rusty. I do hope you will send me another lot this fall, as I want to give them a fair trial.

445. *Statement of E. Miller, Mahwah, Bergen Co., N. J., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 12 carp 3 years ago last autumn. The pond in which I have kept them covers about an acre, is from 5 to 6 feet deep, and has a clay bottom. Five gallons of water flow through it per minute. The temperature is from 30° to 60°.

PLANTS.—There are no plants or grasses growing on the bottom. There is meadow grass around the edges, on which the carp feed at night.

ENEMIES.—The pond contains trout and frogs as well as carp.

GROWTH.—There are 4 or 5 of the original lot left. They weigh 4 or more pounds. My son was walking on the margin of the lake August 13, 1883, and saw one of the original carp in the pond, and captured it by the aid of a scoop-net used in catching frogs. He brought it to the house, a distance of 100 yards, and ascertained its weight to be 5¼ pounds and its length 22½ inches. It was a male carp nearly scaleless and very fat.

REPRODUCTION.—Thousands of young have been produced, which are from 2 to 8 inches long and differ much in shape and color.

DISPOSITION OF YOUNG.—We have stocked two ponds for our neighbors with about 30 carp each.

VARIETIES.—My stock seems to be a mixture of many varieties. They vary in color from yellow to brown, some having a mixture of the two colors. They are unlike, too, in form, and some are wholly and others partly without scales, while others have a compact covering of scales. Some have mouths like the sucker and others like the bass. Some are short and very stout; others are shaped like the codfish and have large and angular heads. The eyes in some seem fixed; in others they turn in their sockets and seem to stare at you. They seem to be a mixture in variety, but all of the sucker (carp) class. I think the full-scaled variety—bass-shaped—are in the majority and will in a short time prevail.

HOW TO CATCH CARP.—They are difficult to catch; shy of nets, and slow to bite. The best bait for them are large, lively angle worms. The full-scaled variety are the easiest to take with gill-nets. The scaleless are baiters, and are about the only ones to take the hook.

446. *Statement of John H. Brakeley, Bordentown, Burlington Co., N. J., Nov.* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I first received carp in November, 1880, but lost that 20 by the breakage of dams. One year ago last October I stocked a pond with 26 leather carp, the pond consisting of about 3 acres. But little water flows through it, as the streams are led around by canals. These fish had been received in November, 1881, being at that time only about 2 inches long, but which had grown during the year to be from 12 to 14 inches in length, and attained an average weight of 1¼ pounds. In another pond, containing ⅜ of an acre, I had at the same time (November, 1881) placed 14 fish of the same size and age as the 26. The water in the small pond was from 12 to 18 inches deep, and its temperature in summer not below 85°. The bottom is sand, clay, and peat.

PLANTS.—The large pond had been constructed before I placed the carp in it, and consequently had a fine growth of aquatic vegetation, and was admirably adapted to carp-culture. The ponds contain the white water-lily (*Nymphæa odorata*), the yellow water-lily (*Nuphar advena*), water starwort (*Callitriche*), water purslane (*Ludwigia palustris*), bur-reed (*Sparganium*), bladderwort (*Utricularia gibba*), hornwort (*Cerastophyllum*), &c.

ENEMIES.—While I had been careful to exclude all other denizens of the water I possibly could, so as to give the carp undisputed possession, there were aquatic intruders in large numbers, the presence of which I had not suspected. There had been

a small leak from an adjoining pond stocked with pike and bass, numbers of sun-fish and minnows—the leak so small as to scarcely attract notice—yet in October last when the water was drawn, to my utter surprise, we took from the collector several pike and catfish, a vast number of mullets, about 20 eels, and several bushels of small fry, consisting of sun-fish, roach, and minnows, with any quantity of tadpoles. My ponds were sadly infested with snapping-turtles, small turtles, and snakes. Of the former my men caught 48 in the early part of the season, and over 100 of the second. The shotgun has made snakes and large frogs scarce. I have examined the stomach of two large frogs and found one to contain a May beetle, and the other a katydid, a grasshopper, and a land beetle. So I conclude that they do no harm to carp.

FOOD.—Having taught my carp to come to a certain place for food, they made their appearance on April 3 last, and continued to come whenever their favorite food—cracker crumbs—was thrown to them, till December 9, when they went into winter quarters. This gives them a long season in which to grow. I have fed them but little, but enough to ascertain that they give a decided preference to cooked food over uncooked. They seemed to have no taste for raw food thrown to them, such as clover and cabbage, but ate greedily of boiled sweet potatoes, squash, and cracked corn. Of bread, and particularly of crackers, they seemed specially fond, but cared little for boiled white potatoes. Their favorite natural food in my ponds is the water purslane, *Ludwigia palustris.* Of this they tear up vast quantities, which floats about in large masses, throwing out roots, and continuing its growth in the water.

GROWTH.—On October 4 last I drew the water from the large pond and found my 26 fish in the collector. On weighing some of them I found them to have attained a weight of from 4½ to 5 pounds. This certainly was a satisfactory growth, and was much beyond my expectations. A fish-hawk was seen to capture one of the carp in the small pond last spring, but all the rest were found on drawing the water in October. The largest in this pond weighed 5 pounds.

REPRODUCTION.—I noticed movements which indicate spawning as early as May 18. I found 15 young carp in the small pond varying from 6 to 11½ inches in length, and the largest weighing 13½ ounces. My carp were too young to have made much increase, being only 2 years old at spawning time. In October last I killed a carp weighing 4½ pounds by severing the chief blood vessel with the small blade of a pocket-knife. It proved to be a female with a well-developed roe, weighing a little over one pound.

EDIBLE QUALITIES.—It was cooked, as fish usually are, by frying. We found it fat, succulent, flaky, and entirely free from troublesome bones. In solidity and flakiness it reminded one of the salmon. All who partook of it pronounced it a first-class fresh-water fish. And while not considering it equal to a six-pound Delaware shad, it is certainly a fair substitute for that most excellent fish during the five or six months preceding its advent in our waters. I think I detected a little of the mullet taste.

HIBERNATION.—My fish are still about, as two days ago they came up after cracker crumbs.

447. *Statement of John H. Brakeley, Bordentown, Burlington Co., N. J., Oct.* 13, 1884.

GROWTH AND REPRODUCTION.—Three years ago this fall I received a few carp from the Commission, and I have just stocked a 5-acre pond with 2,500 young carp, hatched this year, which vary from 2 to 9 inches in length; most of them being from 3 to 5 inches long. I weighed 15 of my large fish and found they weighed 92 pounds, or an average of 6½ pounds each. The heaviest weighed 7½ pounds.

448. *Statement of P. Lorillard, Jobstown, Burlington Co., N. J., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—My 50 carp came in November, 1879. The pond in which they have been kept covers about 3 acres, has a muddy bottom, and is about 12 feet deep in the middle. The water is pumped from a brook and from an artesian well, the water of which is strongly impregnated with iron.

PLANTS.—It contains water-grasses, pond-lilies, and a little wild rice.

ENEMIES.—We have in the pond frogs big enough to eat small ducks, thousands of turtles, and also roach. We have put in some pike to thin the carp out.

FOOD.—The carp are fed with bread crumbs, boiled corn meal, and refuse vegetable tops from the garden.

GROWTH.—I caught one last fall weighing 20 pounds. I think there are some now that would weigh over 25 pounds.

REPRODUCTION.—They have produced thousands of young. The pond is full of carp of all sizes; the number cannot be estimated.

EDIBLE QUALITIES.—I do not think they are worth raising as a food-fish; they are hardly as good as the sucker. I wish we had stocked our pond with white perch.

[The trouble was that he ate his carp in the spawning season. In a subsequent letter his agent informs us that small carp eaten at a different time were pronounced "very fair."—EDITOR.]

HOW TO CATCH CARP.—We catch the smaller ones with worms.

449. *Statement of Amos Ebert, Kirkwood, Camden Co., N. J., Apr.* 20, 1883.

GROWTH.—The carp I received November, 1881, were found in November, 1882, to measure from 17 to 18 inches in length and to weigh over 4 pounds.

REPRODUCTION.—My carp will be 2 years old this summer. A few days ago I saw a disturbance in the pond not noticed before, and I thought they must be spawning. Next morning I saw spawn around the edge of the pond attached to weeds and sticks.

450. *Statement of Hiram Cook, Verona, Essex Co., N. J., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in April, 1881, and 20 more subsequently. I put them into a pond which I made, which was supplied with spring water, and the muskrats dug through the banks so that the carp escaped into the headwaters of the Passaic River, near Little Falls. The supply of water to the pond is sufficient to fill an inch pipe continually.

PLANTS.—There are water-cresses growing in the pond.

GROWTH.—I have only seen or heard of but 2 of them. These were caught by boys fishing, and would weigh about 1 pound apiece.

NEW TRIAL PROPOSED.—I have built up my dam again which the musk-rats destroyed, and would like to stock the pond again and make another trial.

451. *Statement of E. L. Hall, Woodbury, Gloucester Co., N. J., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in the autumn of 1880. The pond in which I put them was 250 feet long and 30 feet wide, excavated in a low piece of ground and fed by underdrains. During the summer the outlet was by sinkage, and the water was quite warm; the balance of the year there is an overflow of from 2 to 6 inches in diameter. Say one quarter of the area was 30 inches deep, the balance not more than 12 inches.

PLANTS.—It contained various kinds of water-grass.

ENEMIES.—There were no other fish in it, but plenty of frogs.

REPRODUCTION.—In the winter of 1881–'82, I saw some of the original fish, and thousands of small fry.

MISCELLANEOUS.—I donated 3 acres, including this lake, to the city for a public square, reserving the sole right to cut ice and take fish from the lake. Some one emptied the pond, fish and all.

452. *Statement of Lyttleton White, Eatontown, Monmouth Co., N. J., July* 31, 1883.

DISPOSITION OF CARP RECEIVED.—I received 12 or 15 carp in the fall of 1880. They were put in a mill pond of from 5 to 10 acres in extent, with a muddy bottom and an average depth of 3 feet, through which flows a brook of about 10 feet in width and 1 foot deep.

ENEMIES.—The pond is inhabited by catfish, suckers, sun-fish, turtles, &c. As none of the carp have been seen or found, either dead or alive, I presume they were all devoured by the catfish. I presume that it would be useless to try again with so many enemies to contend with.

453. *Statement of B. M. Hartshorne, Highlands, Monmouth Co., N. J., Aug.* 7, 1883.

DISPOSITION OF CARP RECEIVED.—In May, 1881, I received about 10 carp. The pond in which I kept them was originally a marsh overflowed at high tides. It covers about 1 acre and has a very muddy bottom. Its greatest depth is 5 feet, gradually shoaling.

ENEMIES.—Besides the carp, there are now in it musk-rats, snapping-turtles and mud-turtles, eels, small perch and sun-fish, and a quantity of fresh-water mussels.

GROWTH.—On draining the pond last May, all the fish escaped under a netting placed across the waste-gate into the Shrewsbury River, an arm of the sea. Two of the carp remained in the raceway below the dam and were returned to the pond. They were about 2 feet 3 inches in length, very stout, and would weigh about 7 pounds each.

454. *Statement of Robert Kirby, Imlaystown, Monmouth Co., N. J., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 small ones three years ago last November. I have kept them in a pond 41 yards long and 15 yards wide. I have 3 ponds, all about one size, and all fed from a spring. The bottom is muddy. About a tile full of water flows through them, which is cool where it runs in, but very warm after it has run through the three ponds, in summer; it is not very cold in winter.

PLANTS.—Water-cresses and other cresses grow in the ponds, and white clover, parsley, and several kinds of grass grow around the borders.

ENEMIES.—The upper pond contains chubs, little copperhead frogs, and speckle-back terrapin. The kingfisher made us a great deal of trouble. We shot the kingfisher and saved 2 carp.

FOOD.—I give corn mush to the carp sometimes, but they pay little attention to it. They feed on snails and water-cress and grass.

GROWTH.—There are 2 leather carp left. We suppose that they would weigh from 6 to 7 pounds; they are the size of shad; when received they were from ½ to ¾ of an inch long.

REPRODUCTION.—We have not seen any young ones yet. I am afraid my carp are both males or both females. I would like to have a few more.

455. *Statement of George W. Hedden, and nine others, Farmer's Hotel, Morristown, Morris Co., N. J., Nov.* 1, 1883.

GROWTH AND REPRODUCTION.—The carp placed in Mr. Charles E. Noble's pond December 2, 1880, first spawned in the spring of this year, and have grown remarkably. One of them is 19 inches long and weighs 3½ pounds.

EDIBLE QUALITIES.—Two mirror carp were cooked at the Farmer's Hotel and the guests thought them very palatable. They were very fat. We deem them a valuable article of diet, which should be raised especially in our country, where there are so many places adapted to their culture.

456. *Statement of B. F. Howell, Morristown, Morris Co., N. J., July* 25, 1881.

DISPOSITION OF CARP RECEIVED.—I received 25 in February, 1881. I kept them in a pond 100 feet square and 18 inches deep, with a muddy bottom. A 6-inch pipe would carry the water which passes through it.

ENEMIES.—It contains catfish, &c.

GROWTH.—My carp weighed 3 pounds when I lost them. Mr. Noble, of this town, has fine luck with his, and they grow very fast and are very tame. It is a great curiosity to see them feed. His pond is pure spring water.

DIFFICULTIES.—The fish you kindly sent me were all carried away by a break in my pond. A neighbor lost his fish in the same way. I should like some more carp for this pond and also for 2 larger ones which I have in other parts of the county.

457. *Statement of Charles E. Noble, Morristown, Morris Co., N. J., July* 31, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp which I received I put into a small pond 100 feet in diameter and 6 feet deep. The bottom is naturally quicksand, but has been filled in 6 inches deep with firm sand such as masons use. About 15,000 gallons of water flow into it daily, directly from springs which have a temperature of 60°. The temperature of the water at the surface of the pond is not less than 70° in summer.

PLANTS.—It contains no plants nor grasses. Its edges are even and riprapped with stone.

ENEMIES.—There are shiners and 6 goldfish in the pond. Frogs, snakes, and musk-rats get in, but are killed by every means I can employ.

FOOD.—We usually give the carp, during the summer, the daily waste from the kitchen, say 4 gallons or so of bread, griddle cakes, and cooked potatoes and other vegetables.

GROWTH.—At least half of the original carp are still in the pond; perhaps all of them. I judge they will weigh from 3 to 4 pounds. They look about as large as a fair-sized shad, though all are not the same size. They would average probably 3 pounds.

REPRODUCTION.—I can see a dozen or more young of last year's hatching, but did not know I had them till last month. They are about 6 inches long and are growing rapidly.

DIFFICULTIES.—They are no difficulty at all, but, on the other hand, we take pleasure in feeding them. They are quite tame now, and come up to take any floating food close in shore. The only objection to them for a pleasant pond on the lawn is that they root around in the bottom and keep the water muddy.

458. *Statement of H. B. Stone, Morristown, Morris Co., N. J., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—On the 1st of December, 1880, I received 20 carp for myself and 140 in custody for others. I received some more in 1882. I have kept them in a pond on Spring Brook farm, the property of John T. Foote, esq. This pond is 250 feet long, 100 feet wide, and 3½ feet deep, and has a muddy bottom. It has no

inlet or outlet except a drainage pipe which I laid, which is 100 feet long and closed by a gate. The temperature of the water is 75° in midsummer. It freezes over in winter; the fish were deposited through a hole cut in ice 6 inches thick.

PLANTS.—It contains what we call "muck-shaws," an aquatic plant with a large pointed leaf and bearing a yellow blossom. The roots of this form "tussocks," which prevent the lead-line of a seine from keeping the bottom. Mr. Rud. Hessel spoke of oak leaves being detrimental. This pond is the recipient of a large quantity, as small oaks were left on the ground when it was cleared.

ENEMIES.—Catfish, snapping-turtle, and the common small land terrapin occur in the pond, and the snakes and kingfishers are troublesome.

FOOD.—The fish in this pond have never been fed. I have tried to feed them, but they never show themselves, and I was in doubt of their existence until yesterday.

GROWTH.—At that time we seined the pond, but among those that we caught only one, to judge from the size, belonged to the original lot. He weighed, I should think, from 2½ to 3 pounds. In the excitement he slipped through our fingers and escaped.

For two parties who receipted for them I placed 40 carp, on the 2d of December, 1880, in one of our reservoirs, from which we obtain our drinking water, which Professor Cook, our State geologist, says, if it has any fault, is too pure. When deposited they were from 2 to 2½ inches long. I caught one in June which measured 6 inches, which I considered a rapid growth, if they hibernate, as they are said to do. These fish are now from 12 to 18 inches in length—I would say, averaging 15 inches—and weigh from 2 to 3 pounds. The water in this reservoir is about 12 feet deep and clear. The bottom is composed of clay, covered with what earthy deposit has accumulated in, say, five years; and the margin is rip-rapped. The fish have been exceedingly shy, and we have never succeeded in getting them to take food.

REPRODUCTION.—In the net 100 feet long which we drew in the pond yesterday we caught 22 carp, besides the old one which escaped us, as related above. Of these, 21 averaged 6 inches in length; those we took to be yearlings. The other was 1½ inches long and was supposed to be of this spring's hatching. The securing of the latter was no doubt an accident, the net having a 1½ inch mesh. The water was muddy when the net was drawn—more so than I had ever seen it; perhaps made so by cattle.

Charles E. Noble, esq., who, together with myself, filed the applications for the first lot of carp that came to this county, has a pond of his own, feeds his carp regularly, and has been successful with them. He never saw his year-old fish until about a month ago, when he discovered them to be about 6 inches in length and abundant.

EDIBLE QUALITIES.—I have not yet eaten any carp. I have never regarded them as choice fish, but if they are equal to a moss-bunker they would give to our people, "hewers of wood and drawers of water," a good many of whom spend half their time in the bowels of the earth, a variety in their diet that is wholesome and nutritious, while those who have the means and leisure can spend both in search of something better.

459. *Statement of E. B. Woodruff, Morristown, Morris Co., N. J., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—About the last of December, 1880, I received about 15 carp. They were put into my pond through 10 inches of ice when there was so little water in it that they must have gone into the muck. The pond had been emptied to get rid of catfish, and had not been filled. This pond covers about an acre, and has a depth of from 2 to 5 feet. It was originally a muck hole, and the bottom is covered with muck. The water runs from November to the last of April. It is supplied wholly by surface drainage, but never dries up entirely. The temperature of the water is quite warm in summer.

PLANTS.—There are no plants in the pond except water-grasses, and—when the field is seeded—timothy grass grows around the edges.

ENEMIES.—It now has no fish in it except the carp, but has the ordinary small frogs of such places, and also small water-turtles.

FOOD.—I have thrown in vegetables and bread to see if there were any fish, but have never seen them take any.

GROWTH AND REPRODUCTION.—Until lately I have not known carp were in the pond, as the water is not at all clear. While I was absent from home, a short time ago, my farmer caught 2, the largest being more than 12 inches long. He says he should think there were 50 more, at least.

460. *Statement of Monroe Howell, Parsippany, Morris Co., N. J., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received 21 carp in 1880. I have kept them in a pond 7 feet deep covering 20 acres, which I built expressly for them. It has a muddy bottom and is fed by springs. The amount of water flowing through it would fill a 4-inch pipe.

PLANTS.—It contains all grasses that are common on ordinary marshy land.

ENEMIES.—It also contains frogs, and abundance of small fish. I don't know of there being any other fish but carp in the pond.

MISCELLANEOUS.—I have never fed the carp and have no means of knowing how many old ones are left or how many young they have produced. I have tried various methods of catching the carp, but have never succeeded. There never has been a carp taken out, for I allow no fishing.

461. *Statement of William H. Howell, Whippany, Morris Co., N. J., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp 3 years ago, and neighbors have since put about 100 more in my pond. My mill-pond, in which the carp were placed, covers about 2 acres, is from 1 to 4 feet deep, and has a muddy bottom. The Whippany River, a small stream, runs in. It is not all spring water.

PLANTS.—Water grass and water weeds grow near the shore. A large part of the surface is covered by what we call muckshaw.

ENEMIES.—The pond contains frogs, turtles to some extent, and all fresh-water fish of our latitude except trout.

MISCELLANEOUS.—I have never seen one of the carp since they were put in the pond. From what I read, I believe my pond to be good ground for carp, and they may be all right; but, at any rate, difficulty would arise in trying to take them.

462. *Statement of Charles S. Medary, Little Falls, Passaic Co., N. J.,* 1882.

PRICE.—My price-list for carp is as follows: Mirror carp, ten months old, $75 per 100; mirror carp, ten months old, selected, $85 per 100; scale carp, ten months old, $70 per 100; scale carp, ten months old, selected, $80 per 100; special rates on large orders. No orders filled for less than $25. Cans for shipping, $2 to $3, according to size.

463. *Statement of Winslow Schoomaker, Singac, Passaic Co., N. J., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in good condition in the fall of 1880, and put them into a pond which covers $\frac{1}{10}$ of an acre, and has a muddy bottom. A stream of water of from 4 to 6 inches in diameter usually flows through it. In July of 1881 I had 14 left, and I felt very proud of them. When the dry weather came on the water got scarce in my pond, and I removed them to other waters. They did well, but in the fall when I wished to put them back I only found one.

GROWTH.—In July, 1881, my fish weighed about ½ pound. The one which I had left I gave to my father-in-law, Louis Klotz, in the fall of 1882; but through some unknown cause it died when he put it in his pond. It then weighed 2½ pounds. Mr. Klotz sent for some carp in the fall of 1881. He managed to save about 6 this summer, which will weigh 3 or 4 pounds.

REPRODUCTION.—Mr. Klotz's fish have spawned, and the young are doing well. He has several ponds and is devoting a large part of his time to them.

464. *Statement of John Collins, Bernardsville, Somerset Co., N. J., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received 23 in December, 1880. I kept them at first in a pond 300 feet square and 4 feet deep, with a bottom of muck and sand; 20,000 gallons of water, of a temperature of 75°, flows through it daily. On the 10th of August, 1882, we had to let the water out of the pond to make repairs, and most of the fish went out into neighboring ponds. We caught 5 and put them in a little muddy pond 25 feet square, and kept them there until October 26, when we killed them to cook.

ENEMIES.—The large pond contains sun-fish, trout, frogs, and turtles.

GROWTH.—The 5 carp caught measured, respectively, 3, 3½, 4, and 4½ pounds. We were sorry that we had to let the pond out, when we found how they were growing.

EDIBLE QUALITIES.—When cooked, they were soft, of poor flesh, and of a muddy taste. I expect from being kept in a little, muddy pond.

MISCELLANEOUS.—We now have our pond thoroughly fixed, and would like to have some more carp.

465. *Statement of J. V. D. Pumyea, Plainville, Somerset Co., N. J., Nov.* 17, 1883.

GROWTH.—The carp which I received and placed in my pond April 6 were taken out yesterday, and measured 16 inches in length. A pair weighed 8 pounds.

466. *Statement of John Dietrich, Plainfield, Union Co., N. J., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—In October, 1880, I received 20 carp, and in June, 1881, I received 20 more. The pond in which I have kept them is irregular in shape, its 4 sides being respectively 40, 23, 33 and 10 feet. Its average depth is 2½ feet and its greatest depth 3½ feet. The bottom is mostly of mud, but is composed of gravel at the sides. There are 3 springs in the bottom, and water flows in through one 3-inch pipe at the surface, and out through a 4-inch pipe, keeping the surface pure. The temperature of the water is from 70° to 76° Fahr. I think it a mistake to keep the water above 76° at any time for health of fish.

PLANTS.—The pond contains water-lily and other aquatic plants; also moss from Rahway River. It has a grass border.

ENEMIES.—I think I have banished all pestiferous turtles and snakes. I think the last snake went this morning.

FOOD.—I have only given the carp wheat bread and corn bread, and at no stated period; usually at evening time, about sunset. I love to sit on some stone steps at the margin of the pond and call up the fish with some nice wheat-bread. They come close to my feet and take their morsel with a relish always.

GROWTH.—I think that there are 3 old ones left. They weigh from 3 to 4½ pounds.

REPRODUCTION.—They have produced thousands of young, but their enemies, which I have been fighting, have kept them thinned down. The young measure from 6 to 10 inches in length.

DIFFICULTIES.—One year ago, in August, 1882, we were visited by an unprecedented storm or cyclone, which deluged our city and the surrounding country. Bridges, and fences, ponds, fish, and all went, but the fish loved their home and remained in the stream outside of my rebuilt pond. Fifty or more were caught and eaten, and I bought 4, and caught 4 of the original ones.

467. *Statement of C. R. Maltby, Plainfield, Union Co., N. J., May* 3, 1884.

DISPOSITION OF CARP RECEIVED.—I received 40 carp February 8, 1880. I put them in a pond containing about ¾ of an acre, which is from 1 to 3½ feet deep, and has a bottom composed of sand and muck. Forty inches of water flow into it from springs within ½ mile. I have put screens at the places where the water enters and leaves the pond, to prevent the fish from escaping.

PLANTS.—There is eel-grass growing in the pond.

ENEMIES.—It also contains catfish, eels, frogs, sun-fish, a few pike, and a few turtles, but no snapping-turtles.

FOOD.—I do not give them any food. Every shower and heavy rain washes the streets of the city and the water flows through the pond.

GROWTH.—I do not know how many of the carp are left. They weighed 2¾ pounds February, 1882, and from 4 to 5 pounds September 6, 1883.

REPRODUCTION.—I have just found in the pond a good many young about 6 inches long.

468. *Statement of Percy C. Ohl, fish warden, Plainfield, Union Co., N. J., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received 25 carp in the winter of 1880. I put them into a spring-water lake about 3 acres in extent, with a muddy bottom, gravelly slopes, and grassy banks. Its greatest depth is 6 feet, and its least 2 feet, the average being 4 feet. About 5,000 gallons of water pass through it every 24 hours. The average temperature for the summer months is 66°.

PLANTS.—The pond is clear of all grasses or plants, except roots from the banks.

ENEMIES.—There are suckers, eels catfish, black bass, minnows, fresh-water terrapins, snapping-turtles, &c., in it.

FOOD AND GROWTH.—I never feed the carp. In the spring of 1882, 20 could be counted. I only have 2 or 3 left now, which are about 24 inches long and weigh, I should say, 7 pounds.

EDIBLE QUALITIES.—A leather carp recently caught in this vicinity, weighing over 6½ pounds, was one of the most toothsome fish I ever tasted.

DIFFICULTIES.—These few carp were planted in my pond in midwinter, it being necessary to cut through a foot of ice to deposit them. The pond then contained quite a number of black bass, and I expected that the carp would be devoured in the spring, or whenever the bass came out again. I was pleased, however, to notice in the following year nearly all the carp, which had grown to be about 6 inches in length. They continued to grow until they were immense, but the freshet of last September made nearly a clean sweep of everything. I have not seen any fish in the pond since, but hear that several very large fish are there.

469. *Statement of J. R. Shotwell, Rahway, Union Co., N. J., Aug. 2, 1883.*

DISPOSITION OF CARP RECEIVED.—In November, 1881, I received 18 carp. They were put in a pond of about 2 acres, belonging to Mr. A. F. Shotwell. It has a clay bottom, is from 4 to 5 feet deep, and receives the drainage of about 100 acres of woodland and meadow.

PLANTS.—It contains *Nymphœa odorata.*

ENEMIES.—There are frogs and turtles in it.

GROWTH.—The old carp are now 11 inches long.

REPRODUCTION.—They have produced a large number of young, which are from 1 to 2 inches long.

DIFFICULTIES.—There has been no difficulty in their care; they take care of themselves.

NEW MEXICO.

470. *Statement of E. S. Stover, Albuquerque, Bernalillo Co., N. Mex., Aug. 10, 1884.*

REARING CARP IN ALKALINE WATER.—I received a lot of carp from Mr. Menaul, at Laguna, N. Mex., in the spring of 1883, he having received them the fall before. As it was the first in this part of New Mexico I gave them some very severe tests, simply to see if they were hardy and would do well in alkali water. I dug a small hole in the ground that was full of alkali, the whole ground about being incrusted with it, and in this hole which filled itself from the surface water I put two of the carp, really expecting that it would kill them. But to my surprise they flourished in it, and if anything, did better than those which I put in the basin of my fountain, which contained pure water from the well.

When winter came I took all of them (some 18) and put them in a large tank of pure cold water fed by a windmill from a deep well, and kept them there until April last without any food whatever, or without any mud or other substance for protection. The tank was about 10 feet deep and froze over several times during the winter, the thermometer standing as low as 14° above zero for several weeks. From this tank I transferred them to a shallow pond dug in the alkali bottom near by, which has simply been supplied from the surface water draining in through the quicksand. In this pond at the age of 2 years and after such treatment they have bred, which I think proves conclusively that they are a very hardy fish. July 27, 1884, the pond was literally full of young from 1 to 3 inches long. I am confident they will be a great success in the Rio Grande Valley and other parts of New Mexico. The Rio Grande is well stocked with catfish, suckers, eels, and several other varieties. I am confident that carp would do finely in it also.

FOOD.—Since putting them in the pond I have fed them liberally on corn-meal mush, wheat bread, spoiled cheese, &c., and they have grown wonderfully.

471. *Statement of John Menaul, of Laguna, Valencia Co., N. Mex., Nov. 9, 1883.*

DISPOSITION OF CARP RECEIVED.—Of the 575 fish received, I lost over 100 during the first 4 months, after which no more of them died. My ponds are fed from a spring 700 feet distant, and are very much sheltered on the east by very high lava masses.

GROWTH.—Owing to the water being so cold they have little more than doubled in size or weight, while others sent to Albuquerque increased 1¼ pounds in weight.

NEW YORK.

472. *Statement of Chauncy Miller, Shakers, Albany Co., N. Y., Aug. 20, 1883.*

DISPOSITION OF CARP RECEIVED.—The 6 carp received on May 10, 1880, I put in a small pond, with a sandy and mucky bottom. It has for 4 months during the year enough water to run a saw and grist-mill, and is quite warm in summer.

PLANTS.—Pond-lilies and various kinds of wild grass grow in the pond.

ENEMIES.—Bass, bull-heads, sun-fish, eels, and turtles are found in the pond.

DIFFICULTIES.—The pond dried up the first summer after the carp were put in and they all perished.

473. *Statement of N. Finch, North Pitcher, Chenango Co., N. Y., Aug. 4, 1883.*

DISPOSITION OF CARP RECEIVED.—The 19 carp received on November 18, 1880, I put in a pond covering about ½ of an acre, with a depth varying from 5 to 6 feet, a muddy bottom, and a temperature varying from 30° to 40°. It is fed by a spring.

PLANTS.—Swamp grass grows in the pond.

ENEMIES.—The pond contains a few frogs.

DIFFICULTIES.—It was very cold when the carp arrived. Only 3 carp appeared after the cold weather was gone, and they, too, soon disappeared.

474. *Statement of Daniel Bidwell, Mellenville, Columbia Co., N. Y., Jan.* 10, 1881.

DISPOSITION OF CARP RECEIVED.—I received 13 small carp May 9, 1880, in good order, and immediately deposited them in my pond, which was not quite completed. The bottom of the pond is composed of clay and sand. In the latter part of August, the season being very dry, I had the water drawn and set workmen to finish digging it out with horses and scrapers.

ENEMIES.—Some days after I planted the carp I noticed the pond was full of frogs, some of large size, and as the fish had not been seen I supposed they had destroyed them.

GROWTH.—After the men had been at work several days 3 carp were seen, one of which was 10 inches long and weighed over a pound. We then saw 9 more in the water, that was about 12 inches deep, in a small space in the center of the pond. The wonderful growth from May 9 to September 9, 4 months, beats anything I ever saw, or of which I ever heard.

475. *Statement of P. A. M. Van Wyck, New Hamburgh, Dutchess Co., N. Y., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The 2 lots of leather carp received 2 years ago I put in a fresh-water creek, full of coves and bays, such as I deem good resorts for carp.

GROWTH AND REPRODUCTION.—Last fall I saw a small school of carp which averaged from 7 to 8 inches long. I have not seen them since.

476. *Statement of Hiram A. Gates, Coxsackie, Greene Co., N. Y., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received in May, 1881, I put in a pond covering about ¼ of an acre, with an average depth of 3 feet, and a muddy bottom. The flow of water is irregular, and is very warm in summer.

PLANTS.—Plants indigenous here grow in the pond.

ENEMIES.—No fish, but plenty of frogs and turtles inhabit the pond.

FOOD.—I do not feed the carp, but there is an abundance of red animalculæ in the pond.

DIFFICULTIES.—In the spring of 1882 I found the remains of 2 carp, each about 10 inches long, and I judge they would have weighed 2 or 3 pounds. These were frozen in the preceding winter, and I fear the others shared a similar fate. I intend to deepen the pond and try the carp again.

477. *Statement of H. D. McGovern,* 288 *Fulton St., Brooklyn, N. Y., Mar.* 30, 1881.

DISPOSITION OF CARP.—I placed 35 carp, 18 months old, some of which weighed 2½ pounds, in a pond prepared for them. The pond, which was constructed for observation and fed from springs, was 3 feet in depth, there being a bottom of mud or fine loam of 6 inches.

FOOD.—I ascertained from experiment that carp disposed of oatmeal dough and a dough of rye meal mixed with chopped cabbage more quickly than any other kind of food given them. If carp are not fed in December, January, and February, they will go in the mud where they will be safer than were they regularly fed.

METHOD OF FEEDING.—In the early part of January I kept an air hole open in the ice which had accumulated on the pond, and fed the fish by means of a wooden spout, 1 foot square and 4 feet long, inclosed in a large sheaf of cat-heads and closed at the opening with a wad of saltgrass to keep the frosty air from entering the tube or shaft. When I wanted to feed my carp I would remove the grass wad and drop my food down the aperture, after which I would obscure the light from the opening by throwing a coat over my head, and would then be rewarded by seeing all the fish within range of the opening at the bottom. My shaft worked well until the temperature fell to zero, for then, notwithstanding the covering of reeds or cat-heads, it closed up, and I was compelled to cut holes in the ice and remove all the particles remaining. After the opening was cleared I would drop in food, and as the fish were not shy they could be seen hovering around the opening after eating.

HARDIHOOD.—They can stand any amount of handling in moderate weather, and live longer out of water than any fish I have ever handled. I can instance a case where a carp that was wrapped by me in a piece of wet bagging was kept out of the water for 2½ hours, when, on placing it in a tank of water, it swam off as if it had only been changed from one tank to another. There was no swooning nor cause for resuscitation.

JUMPING POWERS.—At the lapse of a month or two after placing them in a pond carp have been found in an adjacent one having no seeming connection with the first. The fact is the carp will jump 3 feet, and then, like an eel, wriggle its way over damp grass and make its way to other waters.

CONSTRUCTION OF PONDS.—In northern waters a carp pond should be at least 4 feet deep, with a foot of soft bottom, making in all 5 feet.

478. *Statement of James Annin jr., Caledonia, Livingston Co., N. Y., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in the spring of 1880. The temperature of the water I placed them in is 48°, and is so cold that they did not grow 1 inch the first year. Every few weeks 1 or 2 died, and at the end of the second season I had none of them left.

479. *Statement of M. B. Jarvis, Canastota, Madison Co., N. Y., Sept.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received on January 11, 1881, I put in a pond covering about ½ of an acre, with a depth of from 2 to 3 feet, and a muddy bottom. The water in the pond is kept fresh by the spring and Erie Canal water that flows into it.

PLANTS.—Frog-spittle and eel-grass grow in the pond, and lilies and other varieties of grasses around its edges.

ENEMIES.—Many small turtles and minnows and a few frogs inhabit the pond.

DIFFICULTIES.—I do not know what has become of the carp. I have not seen them since they were put in the pond, though I can hardly believe the fish have been killed, or that they have died, or escaped. There is so much eel-grass and vegetable matter growing in the pond it is difficult to ascertain about the fish.

480. *Statement of Seth Green, Rochester, Monroe Co., N. Y., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—In a pond, 75 by 85 feet, with a depth of 15 inches, and a muddy bottom, I put 10 carp received on May 8, 1880, and others received November 10, 1882, and December 19, 1883. It is supplied by a half inch stream of water which is usually at a temperature of 75° F.

PLANTS AND ENEMIES.—Moss and flags grow in the pond. It is also infested by frogs.

FOOD.—I give the carp chopped liver daily.

GROWTH.—There are from 5 to 6 original carp remaining, which average about 2 pounds. There are no young in the pond.

DIFFICULTIES.—Some of the carp became infected with fungus and died.

481. *Statement of Eugene G. Blackford, Fulton Market, New York City, Mar.* 21, 1882, *and Apr.* 4, 1884.

GROWTH.—I have just received from Mr. J. Reynal, of White Plains, Westchester County, New York, a large live carp measuring 17½ inches in length, which I am going to exhibit on April 1. This is one of the lot received 2 years ago. [March 21, 1882.]

CARP IN JAMES RIVER.—A barrel of shad arrived to-day in our market that were caught in the James River, Virginia. Among them was a German carp, weighing 3½ pounds. [April 4, 1884.]

482. *Statement of L. W. Bristol, Lockport, Niagara Co., N. Y., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 carp received on November 9, 1880, I put in a pond, 20 by 40 feet, with a bottom of clay and mud; 20 gallons of water, at a temperature of 77°, flow through the pond each hour.

PLANTS.—Pond-lilies, flags, and grass grow in the pond.

ENEMIES.—No turtles, frogs, nor other fish inhabit the pond.

FOOD.—I give the carp chopped liver and Indian bread once a week.

GROWTH AND REPRODUCTION.—I have all the original carp. There are in the pond quantities of small fry, with an average of 1½ inches.

DIFFICULTIES.—My pond is only 30 feet above the bed of the Eighteen-mile Creek, where water-snakes abound in great quantities. Last season I shot 17 of them, some of which were 4 feet and 8 inches long, and this season I shot 8, but none over 3 feet long. In this locality they are the most formidable enemy with which the carp have to contend.

MISCELLANEOUS.—Three years ago the fountain basin in Glenwood Cemetery was stocked with goldfish, and in a short time we had about 1,000 young fish. Last

year the fish began to disappear, and on investigation I found that the artificial rock work harbored snakes, which had climbed up to the basin from Eighteen-mile Creek, 50 feet below. These snakes proved such a pest that we have abandoned raising fish in this basin.

483. *Statement of William N. Clark, New York City, N. Y., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The 40 carp received in the fall of 1880 (of which 20 were leather carp), and the 20 carp received in the fall of 1881, I put in a pond 35 by 70 feet, with a depth varying from 1½ to 6 feet, and a muddy bottom. A 3-inch stream supplies the pond with water, except in summer when there is scarcely any flow. It is located near High Bridge

PLANTS.—No plants grow in the pond.

ENEMIES.—Eels and goldfish inhabit the pond.

FOOD.—For about 9 months during the last and the present season bread has been given the carp daily.

GROWTH.—The leather carp average 2¾ pounds in weight and 18 inches in length, and the other variety 1¾ pounds. All of the original are alive. They are easily kept, and are very hearty.

REPRODUCTION.—I do not know whether the young in the pond are carp or goldfish.

484. *Statement of W. A. Conklin, Central Park, New York City, N. Y., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 carp received December 1, 1879, I put in a pond covering 10 acres, with an average depth of 10 feet, and a muddy bottom. Seventy gallons of water flow through it per minute.

ENEMIES.—Goldfish, sun-fish, catfish, white and yellow perch, frogs, and painted turtles inhabit the pond.

DIFFICULTIES.—Other fish have destroyed the carp spawn.

485. *Statement of William G. Crenshaw, P. O. Box* 168, *New York City, N. Y., Aug.* 31, 1883.

DISPOSITION OF CARP RECEIVED.—I have not seen the carp received on January 25, 1881, and January 25, 1882, since I placed them in a pond in Orange County, Virginia. But I think there are plenty of carp in the pond, although they cannot be caught.

486. *Statement of Francis Endicott*, 57 *Beekman st., New York City, N. Y., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The 250 carp received through Mr. E. G. Blackford in 1880, and 64 more received on December 13, 1881, I put in the lakes and ponds of Staten Island. Most of these ponds and lakes are public waters, and are stagnant.

PLANTS.—Pond-lilies and dog-lilies grow in some of the ponds and lakes.

ENEMIES.—Goldfish are numerous, and thrive in the ponds and lakes. Turtles, and from 2 to 3 varieties of frogs, also inhabit them.

GROWTH.—The 4 carp which were found dead in Captain Woods' pond weighed 5 pounds each. Several other members of the Richmond County Game and Fish Protective Association have reported enormous carp in their ponds. The semi-stagnant waters of this county are especially adapted to the successful culture of the carp.

DIFFICULTIES.—Our ponds and lakes are too near the great city of New York.

487. *Statement of F. C. Havemeyer*, 117 *Wall st., New York City, N. Y., July* 31, 1883.

DISPOSITION OF CARP RECEIVED.—The 25 carp received in November, 1879, I put in an ice pond, 45 by 55 feet, with an average depth of 4 feet, and a bottom composed of mud and gravel. The spring water which flows into the pond is sufficient to fill it in the course of a week. The temperature of the pond varies from 70° to 75°. In November, 1882, I received 25 more and placed them in a pond, 50 by 125, contiguous to the smaller one, and built 2 years later.

PLANTS.—No plants grow in the pond. It contains no enemies.

FOOD.—From 3 to 4 times a week I give the carp lettuce and other vegetables. I also feed them on stale wheat and bran bread.

GROWTH.—The 17 original carp remaining average from 2 to 2½ pounds. I have not seen any young yet.

DIFFICULTIES.—When the water was run off from the smaller pond just before the completion of the larger one, several carp escaped.

488. *Statement of W. R. T. Jones*, 51 *Wall st., New York City, N. Y., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—The 6 carp received in 1881 I put in a 1-acre pond, with a depth of 3 feet, and a muddy bottom. The water is quite warm in summer, and does not overflow except in spring.

PLANTS AND ENEMIES.—Duck-weed grows in the pond. Goldfish, frogs, and turtles also inhabit it. I do not feed the carp.

GROWTH.—The original carp average about 14 inches in length.

REPRODUCTION.—There are apparently a number of young in the pond. The carp hybridize with gold fish.

489. *Statement of George P. Ludlam, superintendent New York Hospital, New York City, N. Y., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The 18 carp received in 1881 weighed about an ounce each and were placed in tanks (aquaria) which contain about 300 gallons of water. No plants grow in the tanks.

FOOD.—We give the carp bread, Indian meal, and chopped beef.

GROWTH.—We have all of the original carp, and they average from ¾ to 1 pound. There are no young.

490. *Statement of Barnet Phillips, New York City, N. Y., Oct.* 6, 1882.

HARDIHOOD AND GROWTH.—Some 10 days ago, after the big rains, a man and wagon, going along a road 8 miles from Newburg, in this State, found something flopping in a mud puddle, not more than 3 feet in circumference. He picked up what seemed a nondescript fish to him, put it in his wagon, and jolted on to Newburg. The fish being still alive, it was put in water, and all who saw it failed to recognize it. Finally, the fish was sent to Mr. E. G. Blackford. I had the pleasure of seeing this morning in an aquarium a fine 3-pound leather carp, the same Newburg fish.

491. *Statement of W. H. Schieffelin, New York City, N. Y., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received on November 22, 1880, I put in a lake just inside ocean beach on Long Island, ¼ by ½ mile, with a maximum depth of 10 feet, and the water slightly brackish, but it has no visible outlet.

PLANTS.—White water-lilies and grass grow in the pond.

ENEMIES.—Black bass (large mouth) and perch (not yellow) inhabit the pond.

FOOD.—I never feed the carp.

MISCELLANEOUS.—I have not seen the carp since they were placed in the pond, but presume they are doing well.

492. *Statement of James A. Van Brunt*, 75 *South st., New York City, N. Y., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The 12 carp received on January 10, 1881, I put in a pond at Huntington, in Suffolk County, 25 by 100 feet, with a bottom of white sand, and supplied by springs.

ENEMIES.—Frogs, turtles, eels, and other fish are found in the pond. I never feed the carp.

GROWTH.—Last year I caught one that weighed ½ pound.

DIFFICULTIES.—I sometimes think that the other fish in the pond have eaten up my carp.

493. *Statement of Geo. E. Ward*, 43 *South st., New York City, N. Y., Aug.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—The 6 leather carp received on December 10, 1880, and 22 scale carp received subsequently I put in a ½-acre pond, with an average depth of 4 feet, and a muddy bottom. The brook water that empties in the pond is very warm in summer. There are no plants in the pond.

ENEMIES.—Trout, sun-fish, shiners, sea salmon, eels, and turtles inhabit the pond. I have not fed the carp.

GROWTH.—The original carp that have been seen average from 8 to 10 inches in length. I have seen no young yet.

DIFFICULTIES.—The dam broke and many carp escaped into another pond below, which leads into Cow Bay.

494. *Statement of Edward R. Wilbur, New York City, N. Y., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received on May 28, 1880, and the 10 received in 1881 I put in a pond 1,500 feet long, and from 6 to 50 feet wide, with a depth varying from 2 to 4 feet, and a soft bottom. It is fed by springs, and as the dam is raised above the head of the spring the water filters through the spongy banks.

GRASSES.—Grasses grow in the pond, and roots in the banks.

ENEMIES.—Frogs, speckle tortoise, and painted turtles, but no other fish than carp inhabit the pond.

FOOD.—I give the carp stale bread, potato parings, and oat meal, and they come to the surface for bread, cabbage, lettuce, &c. They dig into the banks for roots.

GROWTH.—There are about half of the original carp remaining. A year ago 1 measured 22 inches in length, and I should judge that they now average from 24 to 26 inches long, and weigh from 4 to 6 pounds. They are quite large, strong, and active.

REPRODUCTION.—I am unable to state the number of young in the pond.

DIFFICULTIES.—Soon after the carp were placed in the pond I found 6 of them dead and partially eaten. I find it almost impossible to catch them even with a net.

95. *Statement of J. T. Watson, secretary Kirkland Fish Society, Clinton, Oneida Co., N. Y., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—We received 9 carp in 1880, 215 in 1881, 40 in 1882, 160 in January, 1883, and 20 in April, 1883. They were distributed in warm bayous and ponds having plenty of water and muddy bottoms.

PLANTS.—Wild plants grow in the ponds and bayous.

ENEMIES.—In some waters there are no other fish. Some contain chubs, California trout, bass, a few turtles, and many frogs. We give the carp no food.

GROWTH.—We have a greater part of the original carp, and they average 2 pounds, and are about 1 foot long. The oldest carp probably spawned this season.

DIFFICULTIES.—Some of the carp of last winter's lot froze during the time occupied in shipping. One was found bitten by some animal, probably a musk-rat.

496. *Statement of Thomas W. Jones, Maynard, Oneida Co., N. Y., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—The 8 carp received on June 19, 1880, and the 12 in the fall of 1880, I put in a half-acre pond, with a maximum depth of 5 feet, and a bottom composed of clay and muck. A 2-inch stream of water, at a temperature of from 60 to 70 degrees, flows into it.

PLANTS AND ENEMIES.—Wild rice and pond-lilies grow in the pond. I cannot free it of turtles. No other fish inhabit it. Minks abound.

FOOD.—I gave the carp green corn.

DIFFICULTIES.—Five months after I received the carp, when they were killed by minks, they averaged 2 pounds. In one year I have killed 30 minks and 3 coons.

497. *Statement of Burton G. Foster, Vernon, Oneida Co., N. Y., Aug.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—The 18 carp received in December, 1880, I put in a pond 60 by 300 feet, with a depth of 5 feet, and a muddy bottom. It is fed by a stream of soft spring water. Until the fall of 1881, the surplus water was discharged through a waste-weir, 18 inches square.

PLANTS AND ENEMIES.—Trees, grass, and sumac grow around the edges of the pond. Nothing infests the pond except, perhaps, frogs.

FOOD.—I gave the carp wheat bran, bread, apples, and pumpkins.

REPRODUCTION.—In the summer of 1881 there were hundreds of young in the pond. The carp grew and multiplied beyond expectation.

DIFFICULTIES.—In the fall of 1881, the dam broke and caused all the carp to escape, except 2 or 3 which were caught by Oneida Indians, who live but ½ mile distant. These were large, nice fish. If I can get more carp I will rebuild my dam.

498. *Statement of William Watson, Whitestown, Oneida Co., N. Y., Aug.* 2, 1882.

DISPOSITION OF CARP RECEIVED.—Three years ago last May I received 10 carp, 8 of which reached home alive. I put them in a small pond on a hillside with southern exposure. The pond covers 350 yards and the lower end is 5 feet deep with a muddy bottom. The third spring I made several new ponds lower down the creek and in one of these ponds I put 3 carp, in the others 5. In June, 1882, I received 10 more and put them in the old pond.

PLANTS.—I planted water-lilies, wild rice, &c., in the ponds that I constructed the third spring.

ENEMIES.—In the lower ponds all sorts of enemies of the carp seemed to thrive and they exterminated all of the 5 old ones. There were musk-rats, minks, turtles, king-fishers, cranes in great quantities, and frogs without number. A small minnow, which I supposed to be a stickleback, also got in. This last spring I found 1 of the 3 lying nearly dead, with a wound on the back of its neck and its tail off. Last winter I transferred the old ones to a new pond and on the following morning I found 2 of them dead. These pests have made such work that I am almost discouraged, but will draw off the ponds and try to exterminate them.

FOOD.—The first year I fed the carp on stale bread and corn.

GROWTH AND REPRODUCTION.—The second year I had over 60 young carp. I subsequently found young in both ponds by the thousands. I exhibited 3 of the old fish and some of the young at our State fair. The largest weighed 5 pounds The wounded carp that was found in the pond weighed 6½ pounds, and the old carp that were found dead in the new pond to which they were transferred weighed respectively 6 and 6¾ pounds. This spring some of the carp last received weighed 1¼ pounds.

DIFFICULTIES.—Vermin and cranes disturb the carp.

499. *Statement of E. L. Van Dusen, Geneva, Ontario Co., N. Y., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The 12 carp received on May 18, 1880, I placed in a pond covering about ⅛ acre, with an average depth of 6 feet. It is replaced with fresh water every 2 days.

PLANTS.—Only a small quantity of eel-grass grows in the pond.

ENEMIES.—Plenty of frogs, but no turtles nor other fish than carp inhabit the pond. I never feed the carp.

GROWTH.—The 7 original carp remaining average from 2 to 3 pounds.

REPRODUCTION.—There were no young in the pond last year, and very few this year. I do not know why they do not increase.

500. *Statement of John Melvin, M. D., Shortsville, Ontario Co., N. Y., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—The 11 carp received in June, 1880, and the 14 in November, 1882, I put in a pond covering ¾ of an acre, with a depth of 5 feet, and a muddy bottom. It never freezes over and has a flow of water of from 2 to 4 inches.

PLANTS.—Moss, pond-lily, flag, and other varieties of water plants grow in the pond.

ENEMIES.—Bull-frogs, turtles, water-snakes, and occasionally water-rats and musk-rats inhabit the pond. Bass and sun-fish were put in the pond by some boys after the carp were received. I think the bass and sun-fish killed my carp.

FOOD.—In the fall of 1882 I gave the carp bread, rice, corn, and wheat daily. They have not been fed since.

GROWTH.—The original carp remaining, when 2 years old, weighed 2 pounds.

501. *Statement of E. Lovejoy, Victor, Ontario Co., N. Y., Sept.* 29, 1884.

GROWTH.—The carp I received in November, 1882, are doing nicely. I saw them occasionally last summer and think they then weighed a pound each, at least. They were from 12 to 14 inches long.

REPRODUCTION.—On drawing my pond I find plenty of small fry. I believe I have thousands of them.

EDIBLE QUALITIES.—We cooked a large carp weighing 62 ounces but we did not like it, it being very fat. If they are not better at other seasons of the year I want no more of them.

502. *Statement of Lewis Beach, Cornwall, Orange Co., N. Y., Aug.* 30, 1883.

GROWTH.—About three years ago last January Mr. S. S. Mapes stocked his pond in the town of Wallkill with 20 carp received from the U. S. F. C., and last year caught one weighing 5 pounds. Tuesday he caught another which measured 2 feet and weighed 5½ pounds. This is a remarkable growth for this kind of fish in a pond where the water is almost all cold spring water. Mr. Mapes expects to exhibit the carp at the fair in Middletown from September 18th to the 21st if a suitable place can be made for it.

503. *Statement of William B. Westervelt, Middle Hope, Orange Co., N. Y., Nov.* 9, 1882.

GROWTH.—On November 5, 1881, carp not exceeding 2 inches in length were placed in the lake at our cemetery. During a freshet some weeks ago the bank was carried away and we lost our fish. Three of them have since been captured just below the

break, and one is now in the possession of Mr. E. G. Blackford, of New York. The other two I have in a small temporary pond with those just received. The 3 measure 16 inches each, and will weigh 3 pounds. They seem to like to get down in the mud since the cold weather commenced and seem rather dormant.

504. *Statement of Wickham T. Shaw, Middletown, Orange Co., N. Y., Aug.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received in January, 1881, I put in a mill-pond covering about ½ of an acre, with a maximum depth of 7 feet, a muddy bottom, and fed by a stream that is warm in summer.

PLANTS AND ENEMIES.—Plants indigenous here grow in the pond. Catfish, a few bull-frogs, and occasionally snapping-turtles are found in it. I do not feed the carp.

DIFFICULTIES.—I have not been able to seine out any of the carp, but I have been informed that they have been seen up the stream, and large in size.

505. *Statement of Chas. E. Harr, Newburgh, Orange Co. N. Y., Sept.* 30, 1882.

DISPOSITION OF CARP RECEIVED.—On the 5th of November, 1881, 25 young carp were put in the cemetery pond, of which Mr. William Westervelt is keeper. It is located at Cedar Hill, 7 miles north of here.

GROWTH.—Mr. Westervelt caught one of them the first of last April, which was 8 inches long and weighed over a pound. To-day one weighing about 2¾ pounds and measuring 15 inches in length, was taken from a shallow pool which connects with the cemetery pond by a small brook.

VITALITY.—The 2 gentlemen who were driving by noticed it in water scarcely deep enough to cover it. They picked it up and brought it in their carriage to town, and when placed in my aquarium it revived. It was probably washed out of the pond which was broken during the recent high water, and had several bruises on it.

In addition to the above test the carp was put in a small bait-kettle, and sent to Mr. E. G. Blackford, Fulton Market, New York, for identification. He pronounced it a fine specimen of the leather carp, and stated that he had forwarded, through Hon. Lewis Beach, small carp to that neighborhood in November, 1881. It had grown in 10 months from 2 ounces to 46 ounces.

506. *Statement of John C. Donaldson, Gilbertsville, Otsego Co., N. Y., Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—During the first winter I kept the 20 carp received in November, 1880, in a spring. In the following May I put 9 in a pond covering 20 square rods, with a depth all the way up to 2 feet, and a bottom of mud from 2 to 5 feet deep. In wet season the flow of water is 2 inches, but during the dry season only a small spring in the pond supplies it with water. It is always cool at the bottom, and in very warm seasons the surface water is 80°.

PLANTS.—In the shallow parts of the pond grow rushes (*Eleocharis palustris*), with a little scratch-grass, cat-tail flag, and pimpernel.

ENEMIES.—All kinds of frogs and lizards, many water-beetles, and larvæ of dragon-flies, but no fish nor turtles inhabit the pond. Before but not since the carp were put in the pond toads frequented it to lay their eggs.

FOOD.—I give the carp crumbs daily. Buckwheat cakes seem to be their favorite food. For nearly 2 years I did not feed them. Last summer they dug up all the rushes, leaving the stems to float upon the surface of the water.

GROWTH.—Occasionally I see from 3 to 4 of the original carp. Last April I caught one that weighed 2 pounds and 10 ounces, and I estimate their present weight to vary from 2 to 5 pounds. The 7 I left in the spring do not average more than 4 inches in length. During the first winter 4 died.

REPRODUCTION.—I have counted 100 young at one time. Last year's young, having been fed frequently, grow much faster than the original lot, and average ½ pound each. This year's fry are very small, and a few weeks since they became so tame as to eat out of my hand.

DIFFICULTIES.—Two or three times most of the water has escaped from the pond through the holes made in the dam by frost and mice.

507. *Statement of J. T. Welton, Schenevus, Otsego Co., N. Y., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The 11 carp received on June 1, 1880, I put in pond 40 by 75 feet, with a depth varying from 1 to 3 feet, and fed by a 3-inch stream of cold spring water.

PLANTS AND ENEMIES.—Marsh grasses and various kinds of weeds grow in the pond. Frogs alone also inhabit it.

FOOD.—I give the carp crackers or bread, but not oftener than once in 2 weeks.

GROWTH.—The 4 remaining carp average from 4 to 6 pounds.

DIFFICULTIES.—Small boys killed 5 carp; 2 others, one of which was full of spawn, jumped over the dam and perished. I am at a loss to know why the ones remaining do not increase.

508. *Statement of Niram Vaughn, Worcester, Otsego Co., N. Y., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received on November 26, 1880, and 15 in December, 1881, I put in a pond 30 by 40 feet, with an average depth of about 3 feet and a muddy bottom. It is supplied with spring water, which is cool in summer and warm in winter.

ENEMIES.—The pond is inhabited by nothing that disturbs carp.

DIFFICULTIES.—The first lot of carp were sickly when received, and soon died. The second lot I have not seen since I placed them in the pond.

509. *Statement of Thomas Clapham, Roslyn, Queens Co., N. Y., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received in 1881 and the 20 more received in 1882 I kept in a small pond 12 by 25 feet until August, 1883, when I removed them to a 2-acre pond. This pond has an average depth of 4 feet and a bottom of mud and clay. A constant 8-inch stream of water flows into it. In summer the temperature is about 65°, and in winter it rarely freezes over.

PLANTS.—White pond-lilies, water-cress, conferva (frog-spittle), and various kinds of grass grow in the pond.

ENEMIES.—Common brook trout, California brook trout, minnows, frogs, eels, and 3 varieties of turtle inhabit the pond.

FOOD.—As the pond contains a great quantity of natural food, I never feed the carp. They eat conferva, and are causing it to disappear from the pond.

GROWTH.—In August, 1882, the largest carp weighed 6 ounces, and in June, 1883, one that I caught with an artificial fly weighed 3 pounds. This great growth is to me simply wonderful. Daily I see 8 in a school, and they are growing rapidly.

REPRODUCTION.—This summer I noticed many small fish about $1\frac{1}{4}$ inches long, which are different from any I have seen. I think they are carp.

HARDIHOOD.—Having tried various experiments with individual carp, I am convinced that they will thrive in muddy and stagnant water. I have 3 which have been in a box sunk in the ground in my garden since last fall. Although the water in it is stagnant and during warm weather very offensive, yet the carp remain healthy. We have hundreds of surface-drainage ponds on Long Island, in which carp would do well and furnish a deal of cheap food in places where fish are rarely obtainable.

510. *Statement of Mrs. Leonice M. S. Moulton, Roslyn, Queens Co., N. Y., Oct.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received 22 carp December 15, 1880; cut the ice and put them in. My pond covers about an acre, and has a muddy bottom. I put a wire screen over the outlet in the winter of 1881–'82. The screen became clogged with leaves; the water rose in my absence, and broke a place in my dam, through which I think the carp escaped. The pond is fed from small springs on the hillside with very cold water, but the surface water at the outlet is warm. The leaves from willow, cedar, sycamore, and wild cherry trees form *débris* and mud at the bottom.

PLANTS.—The pond is particularly free from plants. Wild roses, alders, clematis, ferns, milk-weed, Virginia creeper, and wild grape grow along the bank.

ENEMIES.—The pond contains a few sun-fish, minnows, frogs, and turtles.

FOOD.—I did not feed the carp, but thought of throwing bread on the surface, as I saw the old women do at Fontainebleau, France, but not seeing any carp I did not throw away any bread.

MISCELLANEOUS.—I believe my pond adapted to carp culture, and am anxious to know where the carp are.

511. *Statement of O. D. Burtis, Syosset, Queens Co., N. Y., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received about 3 years ago I put in a pond covering about 5 acres, with a maximum depth of 7 feet and a muddy bottom. It has no outlet.

PLANTS.—I keep the pond free of plants.

ENEMIES.—Sun-fish, goldfish, eels, turtles, and frogs are found in great numbers in the pond. I do not feed the carp.

DIFFICULTIES.—The enemies of the carp that inhabit the pond destroyed them.

512. *Statement of George L. Smith, Whitestone, Queens Co., N. Y., Aug. 6, 1883.*

DISPOSITION OF CARP RECEIVED.—The 12 carp received in the fall of 1881 I put in a pond 150 feet square, with a depth of 6 feet in the center and a muddy bottom. It is fed by a spring, and has a small discharge of surplus water.

PLANTS AND ENEMIES.—Grass grows on one side of the pond. There are some frogs in it.

DIFFICULTIES.—I have only seen the carp two or three times since placing them in the pond.

513. *Statement of Abe Winant, Rossville, Richmond Co., N. Y., Oct. 2, 1883.*

GROWTH.—One day this week I caught a carp weighing 5 pounds in the pond of Mr. Kennard. These fish were put in the pond some three years ago, about an inch long. I have no doubt that there are carp in the pond that will weigh 8 pounds. They probably spawned last spring.

HOW TO CATCH CARP.—The bait used in catching the carp was a crust of bread.

514. *Statement of John F. Hauptman, Pomona, Rockland Co., N. Y., July 31, 1883.*

DISPOSITION OF CARP RECEIVED.—The 20 carp received on November 29, 1880, I put in a mill-pond covering about 7 acres, with a maximum depth of 8 feet and a muddy and sandy bottom. The water supply is not sufficient to run a mill. The pond contains a great many springs on one side, where the water is cold. In other parts it is warm.

PLANTS.—Plants are only to be found where the water runs up into the bogs.

ENEMIES.—Perch, suckers, shiners, catfish, and sun-fish abound in the pond. I have not seen the carp since I placed them in the pond.

515. *Statement of N. S. Rutter, Sparkill, Rockland Co., N. Y., July 27, 1883.*

DISPOSITION OF CARP RECEIVED.—The 20 carp, about 3 inches long, received on November 12, 1880, I put in a pond covering about 1 acre, with a muddy bottom, and fed by a good flow of cold spring water.

ENEMIES.—Snapping-turtles got in the pond in July, 1881.

GROWTH.—In June, 1881, 3 carp averaged 7 inches in length.

DIFFICULTIES.—As I have not been able to catch any carp since the snapping turtles got in the pond, I fear the turtles have destroyed them.

516. *Statement of Henry D. Grindle, M. D., Spring Valley, Rockland Co., N. Y., July 27, 1883.*

DISPOSITION OF CARP RECEIVED.—The 10 carp received on May 10, 1880, I put in a pond covering 3 acres, with a depth varying from 2 to 20 feet, and a muddy bottom. A sufficient supply of water flows into the pond to maintain a uniform depth, except during a freshet, when it runs from 10 to 12 inches above the screened sluice-way.

PLANTS AND ENEMIES.—Water-lilies grow in the pond. This fall I shall try to free the pond of the small turtles and sun-fish that inhabit it.

FOOD.—I give the carp stale bakers' bread daily, and about an hour before sundown I sometimes feed them on lettuce, boiled cabbage, and cracked boiled corn.

GROWTH.—The 2 carp remaining recently weighed 14 and 15 pounds, respectively.

DIFFICULTIES.—Had I constructed a wire screen over the sluice-way when I received the carp, I would doubtless have raised all of them.

517. *Statement of A. S. Pease, Saratoga Springs, Saratoga Co., N. Y., July 30, 1883.*

DISPOSITION OF CARP RECEIVED.—The 10 carp received on May 12, 1880, I put in my pond, in Rensselaer County, covering about $\frac{1}{6}$ of an acre, and fed by a bold stream from springs.

PLANTS AND ENEMIES.—Common grasses grow on the edges of the pond. Common brook fish, chiefly minnows, inhabit it.

FOOD.—I gave the carp no food.

DIFFICULTIES.—The carp had grown considerably before the dam broke last winter, when all of them escaped into the Hoosic River. My pond is now secure, and I desire more carp.

518. *Statement of P. Rust, Franklinton, Schoharie Co., N. Y., Apr. 25, 1884.*

DISPOSITION OF CARP RECEIVED.—The 21 carp received on December 24, 1880, I put in a $\frac{1}{4}$-acre pond, having a maximum depth of 7 feet, gradually decreasing in depth towards the shore. The bottom is composed of mud and clay. The small

spring which feeds the pond hardly supplies enough water in hot, dry weather to equal the amount lost by evaporation. The temperature of the pond in August is 70°.

PLANTS.—Plants common to boggy or marshy places grow in the pond, which also contains a vast quantity of frog-spittle.

ENEMIES.—Nothing that disturbs the carp inhabits the pond.

FOOD.—I give the carp boiled rye and the refuse from the table occasionally, but with no regularity. The carp would not eat the food given them last summer, as the pond afforded a bountiful supply.

GROWTH.—The 5 carp remaining average more than 20 inches in length, and weigh nearly 6 pounds each.

DIFFICULTIES.—My pond was not ready when the carp arrived, so I had to winter them in a spring, consequently losing all but 5. I have found no little difficulty in constructing my pond properly.

519. *Statement of T. V. Smith, Sharon Springs, Schoharie Co., N. Y., Sept.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—The 12 carp received on May 13, 1880, and 19 in November, 1882, I placed in ¼-acre pond, with a depth varying from 1 to 5 feet, a muddy bottom, and fed by an inch stream of spring water. The temperature is 75°.

PLANTS AND ENEMIES.—Water-lilies grow in the pond. One goldfish and the carp are all that inhabit it.

FOOD.—I give the carp crackers and oatmeal.

GROWTH.—The 1 remaining of the original carp is 20 inches long, and those of the second lot, which are doing well, average 6 inches in length. There are no young yet.

520. *Statement of J. Otis Fellows, Hornellsville, Steuben Co., N. Y., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—The 19 carp received on November 17, 1880, I put in a pond 80 rods long by from 20 to 50 feet wide, formed in an old bed of the river. It has no current, but the rise and fall of the river affects it, as it is open at the lower end. It is from 2 to 12 feet deep, and has a muddy bottom.

PLANTS AND ENEMIES.—Cat-tails and swamp-grass grow in the pond. Frogs, suckers, chubs, shiners, and bull-heads are found in it.

FOOD.—I do not feed the carp.

GROWTH.—This spring, a dead carp 17 inches long, 5 inches in thickness, and 3½ pounds in weight was found.

DIFFICULTIES.—Poachers fish for the carp. When I have a suitable place for the carp, I will want more.

521. *Statement of John E. R. Patten, Hornellsville, Steuben Co., N. Y., Dec.* 22, 1883.

DISPOSITION OF CARP RECEIVED.—In the summer of 1880 I received 9 carp. My pond is 20 by 36 feet. The water is 3½ feet deep, and the bottom is muddy. This pond is supplied with water by a small rill. The water is medium cold. The carp died the first winter. The weather was severely cold, and I think they died from being frozen or from suffocation. I found the remains of them in the spring of 1881.

PLANTS.—The pond contains ordinary water-plants.

ENEMIES.—Frogs only in pond.

FOOD.—I gave the carp bread crumbs daily.

522. *Statement of C. D. Northrop, Woodhull, Steuben Co., N. Y., Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received on August 6, 1880, and those received subsequently, I put in a pond 16 by 64 feet, with an average depth of 2 feet, and 8 inches of mud on the bottom. Probably 50 barrels of water, at a temperature of from 55° to 75°, flow through the pond per day.

PLANTS.—Plants indigenous here grow in the pond.

ENEMIES.—A few small frogs and plenty of water-snakes, but no fish nor turtles inhabit the pond.

FOOD.—I did not feed the carp.

GROWTH.—In October, 1882, the 2 original carp remaining weighed, respectively, 1¼ and 1½ pounds. They grew rapidly, and would soon have attained an enormous size. I am at a loss to know the cause of the disappearance of some of the original carp, and why those remaining do not spawn.

523. *Statement of E. B. Sutton, Babylon, Suffolk Co., N. Y., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received on December 7, 1880, I put in a small pond, with a depth of 5 feet, a good outlet, and fed by a large pond. As the water got very hot in summer, I removed them to a mill-pond covering about 20 acres, and supplied with an abundance of water.

PLANTS AND ENEMIES.—Pond-lilies grow in the pond. The book trout that inhabit the pond probably fed on the carp.

FOOD.—While in the small pond, I gave the carp bread and cabbage leaves. I seldom give them any food now.

CARP IN SOUTH BAY.—The carp escaped into South Bay when my mill was undergoing repairs. I learn that carp of large size have been taken there.

524. *Statement of Lester H. Davis, Coram, Suffolk Co., N. Y., Sept.* 2, 1883.

GROWTH.—A few days ago I took from my pond 2 leather carp weighing, respectively, 5 and 5½ pounds. When they were placed in the pond 2 years ago they were nothing but an inch of transparency with a bullet head at one end.

EDIBLE QUALITIES.—The larger of these 2 carp was eaten at the Ichthyophagous Club in New York. The officers voted it excellent eating.

HOW TO CATCH CARP.—I caught the carp with hook and line.

SALE OF CARP.—I placed these carp at Mr. Blackford's stand in Fulton Market. These 2 fish have had no appreciable effect on the markets, but I think carp will soon be an important item in the bill of fare in the Southern and Western States.

525. *Statement of Stehlin & Co., Huntington, Suffolk Co., N. Y., Sept.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—The 86 carp received in December, 1880, I put in a pond covering over 9 acres, with a sandy and muddy bottom. It is fed by springs, and has no outlet except through gravel.

PLANTS AND ENEMIES.—A mossy vegetation is found in the pond. Small frogs and water-turtles infest it.

FOOD.—I do not feed the carp.

GROWTH.—The original carp weigh from ½ to 1½ pounds. I have seen no young yet.

DIFFICULTIES.—Poachers visit the pond.

526. *Statement of Irad W. Gildersleeve, Mattituck, Suffolk Co., N. Y., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I put the 30 carp received in October, 1881, into a ½-acre pond, which after much rain is sometimes increased to from 2 to 3 acres. It has a bottom of clay, and, as it is supplied only by rain-water, it occasionally dries up. In September, 1882, I removed from 6 to 8 of the carp to a pond covering from 20 to 30 acres, with a depth of from 15 to 20 feet. In 1882 I received another lot, and placed them in a pond covering from 40 to 50 acres, and being very deep.

PLANTS.—Timothy predominates in the small pond, which is formed in a grass lot.

ENEMIES.—Nothing that disturbs the carp inhabits the small pond. The large ponds are stocked with black bass, pickerel, perch, roach, catfish, &c.

FOOD.—I do not feed the carp.

GROWTH.—Two of the carp of the lot that I removed to the large pond weighed, respectively, 2 and 2¾ pounds. The others were very much smaller. The original carp were rapid growers.

DIFFICULTIES.—In September, 1882, the small pond dried up, and all the carp except the ones removed to the large pond perished.

527. *Statement of John C. Wells, Mattituck, Suffolk Co., N. Y., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The 18 carp received in May, 1881, I put in a pond covering about 2 acres, with a depth varying from 1 to 6 feet. It is fed by springs from an upper pond, and has an outlet into Peconic Bay. It is protected by a valve in the dam, so constructed as to allow the passage of the discharge water from the pond, but closes when the tide rises, thereby preventing the entrance of salt water.

ENEMIES.—Eels got into the pond from Peconic Bay.

DIFFICULTIES.—As the carp have not been seen since they were put in the pond, I am inclined to think that the eels devoured them.

MISCELLANEOUS.—If I can get another supply of carp I will place them in a smaller inclosure, which is free from all fish, till they are large enough to be put in the larger pond.

528. *Statement of Samuel J. Hopkins, Miller's Place, Suffolk Co., N. Y., Oct.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received 10 carp in May, 1880. My pond covers ¾ of an acre, has a bottom of sand, mud, and bog, and water from 2 to 4 feet deep. The water changes about once a week and stands at about 74° in summer.

ENEMIES.—Frogs and eels are found in the pond.

FOOD.—In the first part of the summer I gave them wheat, corn, and potatoes twice a week, but later not so often.

GROWTH.—I still have about all of them, and they weigh from 6 to 8 pounds.

REPRODUCTION.—In 1881 there were several thousand young; since that not many. The 1881 brood would now weigh 3 to 5 pounds each. I have supplied about 600 carp to stock neighboring ponds.

EDIBLE QUALITIES.—I have eaten one carp which was half baked and half fried, and think them very good, very much like bluefish.

DIFFICULTIES.—The most serious difficulty has been the eels and frogs. The carp do not seem to thrive real well, but I have not determined the trouble.

529. *Statement of George W. Hopkins, Mount Sinai, Suffolk Co., N. Y., Oct.* 10, 1880.

GROWTH.—The carp received through Mr. E. G. Blackford were about 3 inches in length, but by October 1, 1880, measured from 12 to 14 inches each.

530. *Statement of Edward Thompson, Saint Johnland, Suffolk Co., N. Y., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—The 25 carp received November 6, 1880, I put in a pond covering about 10 square rods, from 1 to 4 feet deep, having a muddy bottom. The water, of which very little flows out of the pond, is quite warm in summer, though it freezes over in winter.

PLANTS.—Flags and rushes grow in the pond.

ENEMIES.—Bull-frogs and plenty of common frogs and small water-turtles infest the pond.

FOOD.—I have given the carp cabbage, clams, lettuce, and bread. They are very fond of minnows when scaled, and, in fact, eat almost anything given them.

GROWTH.—The 22 original carp remaining vary in weight from 3 to 6 pounds, and 1 of them would, perhaps, weigh 8 pounds.

REPRODUCTION.—There are many young in the pond, and also quite a number of yearling, which vary in weight from 8 to 16 ounces.

EDIBLE QUALITIES.—It would be an utter impossibility to take any fish out of a muddy hole and expect it to taste like a fish out of a pond with pure, clear water such as you could stoop down and drink out of. One fact which cannot be got over is that different food and water will make either animal, fowl, or fish taste differently, no matter where they come from or what their names are. I once sent Mr. Eugene G. Blackford two brook trout, about ½ pound each, and asked him his opinion as to flavor, and he pronounced them as good, if not better, than any he had ever eaten. Why? Because they were fed on the natural food for trout. Again, I have eaten trout that tasted very distinctly of liver. Why? Because they were fed on liver. It is the food and water which makes the carp have so many different tastes.

I might ask one more question. Can you find two even in one family to whom things taste alike? It is not so in mine. I would venture to say it would be the same with beef, pork, or any other fish, no matter where it came from.

The carp is the best fish I know of for workingmen and mechanics, who rarely lack an appetite, and who will always consider the fish good when they can get it. My personal opinion is that it is a very superior fish, and I will even go so far as to say that I prefer it to trout.

MISCELLANEOUS.—I expect to have a pond covering about 5 acres, and at all seasons of the year a depth of water varying from 1 to 10 feet.

531. *Statement of J. B. Hawxhurst, Homowack, Ulster Co., N. Y., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received in May, 1881, I put in a pond 240 feet in circumference, with a muddy bottom. A small vein of moderately cool spring water feeds the pond. Plants do not grow in the pond.

ENEMIES.—Shiners inhabit the pond.

FOOD.—Occasionally I give the carp potatoes, bread, and other food.

GROWTH.—Yesterday I caught a carp that measured 15 inches in length. Had I fed them well I think they would have been double their present size.

REPRODUCTION.—The young in the pond average from 3 to 4 inches in length.

532. *Statement of William E. Sill, Sodus Point, Wayne Co., N. Y., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received in May, 1881, I put in a ¼-acre pond, with an average depth of 1 foot, and a muddy bottom. A varying supply of surface water feeds the pond.

The pond dried up in the fall of 1881, and all the carp perished.

533. *Statement of George W. Dibble, Irvington, Westchester Co., N. Y., Oct.* 31, 1883.

DISPOSITION OF CARP RECEIVED.—On November 25, 1879, I received 12 carp, and on November 21, 1882, 20 more. My pond covers several acres, is from 6 to 10 feet deep, and has a muddy bottom.

PLANTS.—Plants indigenous here grow in the pond.

ENEMIES.—The pond is inhabited by frogs and turtles, shiners, and sunfish.

FOOD.—I do not feed the carp.

GROWTH.—October, 1882, I caught 5 original carp. The largest weighed 8½ pounds and the rest 7 pounds and over. When caught they appeared to be ready to spawn.

EDIBLE QUALITIES.—I have eaten carp boiled and baked. They are very good when boiled, but better when baked. The edible qualities of the carp are fair.

534. *Statement of Samuel K. Satterlee, Rye, Westchester Co., N. Y., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 carp received November 1, 1880, the 20 in the fall of 1881, and the 2 one-year old carp that I bought I put in a pond, oval in shape, about 40 by 100 feet, with an average depth of 3 feet, and a muddy bottom. There are 2 holes in the bottom, with sides of stone, one of which is 3 by 10 feet and 3 feet deep; the other is circular in shape, with a diameter and depth of 4 feet. From September to March the flow of water is from 2 to 3 inches, and from June 15 to September 1 it is not equal in amount to that absorbed by the earth and that consumed by evaporation. To-day, at 5 o'clock, the temperatdre of the water 3 feet below the surface is 77°.

PLANTS.—There are no plants in the pond except a few water-lilies which I planted; nor is there vegetation at its sides, as it has a stone wall.

ENEMIES.—Occasionally frogs, but no other fish than carp, inhabit the pond.

FOOD.—Every afternoon I give the carp stale bread, and occasionally I feed them on boiled potatoes and hominy made into Indian cakes, all of which they like. I sometimes throw in water-cress, but they do not seem to relish it.

GROWTH.—In the fall of 1881 I gave away 6 original carp, and 6 more were stolen, 1 of which was fully 10 inches long. There are none of the original carp remaining. I have from 6 to 8 of the second lot, which average from 5 to 7 pounds.

REPRODUCTION.—Besides the number of young carried off by an overflow, and the ones eaten by frogs, fish-hawks, &c., I have about 1,500. Of this number, 30 average 7 inches in length, 1,000 from 3 to 4 inches, and some others are still smaller.

DISTRIBUTION OF YOUNG.—I distributed gratuitously to owners of ponds 400 young in the fall of 1882, and 150 more in the spring of 1883. I also intend to give away what young I may raise in the future, except a few which I shall keep for breeding purposes. In October next I will put from 6 to 8 of the largest in a smaller pond, where I will also place California trout, in order to ascertain the self-sustaining power, growth, and age of the carp.

MISCELLANEOUS.—The reason why I have not lost any carp by ice, which forms over my pond to the thickness of 2 feet, is that the trenches or holes before alluded to afford them protection from the severity of the winter. The bottoms of these trenches should always be 4 feet from the ice. They also afford the carp a cool retreat in warm weather. I have partially constructed another small pond, with a depth of 3½ feet, and it always has a plentiful supply of pure, cool spring water. The carp seem to grow more rapidly in this pond, where a larger supply of natural food is obtainable, and do not rise to the food offered them. When completed the pond will be 40 by 100 feet.

535. *Statement of C. Deutermann & Son, White Plains, Westchester Co., N. Y., Apr.* 2, 1884.

GROWTH.—We received 20 carp about 18 months ago. Six of these survived, and have grown to such size that we have taken great interest in them. If more can be obtained, we will stock all of our ponds with them.

NORTH CAROLINA.

536. *Statement of Thomas L. Martin, Harrisburg, Cabarrus Co., N. C., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received in February, 1880, and the ones in December, 1882, I put in two ponds, covering, respectively, ½ and ¼ of an acre. They are on a spring branch, and have a maximum depth of 5 feet, and muddy bottoms. From 1 gallon to 2 gallons of water flow through them per minute.

PLANTS AND ENEMIES.—Grass, swamp-lily, and flag or cat-tail grow in the pond. Frogs and turtles, but no other fish, inhabit it.

FOOD.—I sometimes give the carp bread and cabbage.

GROWTH.—In the fall of 1882 the original carp averaged 4½ pounds.

REPRODUCTION.—June 9, 1883, I saw signs of spawning, and 14 days later there were a great many young in the pond.
DIFFICULTIES.—Poachers visit the pond.

537. *Statement of C. A. Barringer, Springville, Cabarrus Co., N. C., Sept.* 22, 1883.

GROWTH.—I have just drained my pond, and find 4 fine carp about 14 inches long of those you sent me last February.
ENEMIES.—I caught a turtle in July, and also a very large snapping-turtle, which I think had eaten the others.

538. *Statement of Dr. R. L. Beall, Lenoir, Caldwell Co., N. C., Feb.* 28, 1883.

REPRODUCTION.—I placed in my pond 47 young carp less than 2 years ago. On draining it I now find 2,000 carp.

539. *Statement of J. A. Dula, Lenoir, Caldwell Co., N. C., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—On November 1, 1882, I received 20 carp, which I gave to a neighbor, I having received 130 from Col. G. N. Folk. My pond covers an acre, and is so constructed that the water can cover a larger area when needed. It is 2 feet deep, and has a bottom of black loam. There flows through the pond about 1½ inches of water.
PLANTS.—Wild oats, rushes, &c., grow in the pond.
ENEMIES.—I try to exterminate the frogs and turtles. There are no other fish in the pond.
FOOD.—The carp are very fond of wheat bread and watermelons. I do not feed them regularly.
GROWTH.—Some of the carp weigh 2 pounds. All of them are growing rapidly and are creating a sensation in my neighborhood. I think the carp a very hardy fish.

540. *Statement of George N. Folk, Lenoir, Caldwell Co., N. C., Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—The 17 scale and 3 leather carp received on December 7, 1880, I put in a pond covering less than ½ acre, having a width varying from 3 to 25 feet, and a depth from 1 to 7 feet. Cool water from a spring at the head of the pond discharges just enough water into it to prevent stagnation.
PLANTS.—Rushes and reeds grow in the pond, and the bloom and seed of pussy willow and sycamore trees are blown upon its surface.
ENEMIES.—Frogs, turtles, and snakes are a serious annoyance to the carp. No other fish inhabit the pond.
FOOD.—In winter, the carp take scarcely any food, but are ravenous in summer and come to the top for the wheaten bread that I throw upon the water. They will eat anything that is given to chickens and pigs, and are less expensive to raise.
GROWTH.—There are 15 carp remaining. The leather are the largest and average from 6 to 7 pounds.
REPRODUCTION.—There are several thousands of young in the pond, and they vary in size from 1 inch to 14 inches.
DISPOSITION OF YOUNG.—I have given young to my neighbors to stock their ponds. I have still many applications for young.
HARDIHOOD.—Carp are thrifty, and can be more easily raised than any fish that has been cultivated in this hilly country. They are attracting general attention, and are wanted by nearly every enterprising landowner.

541. *Statement of J. A. Long, Yanceyville, Caswell Co., N. C., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received in December, 1879, I put in a pond covering about ¼ acre, with an average depth of 3½ feet, and a muddy and sandy bottom. A small spring supplies the pond with water.
PLANTS AND ENEMIES.—Flag or cat-tail grows in the pond. I cannot rid it of cat-fish, perch, terrapins, and loggerhead turtles.
FOOD.—Occasionally I give the carp corn and corn-bread.
GROWTH.—The 10 carp remaining, average about 5 pounds. I have seen a carp which was 15 months old that weighed 4 pounds.
REPRODUCTION.—There are many young in the pond, and the oldest average about 1 pound in weight.

542. *Statement of Ira A. Fitzgerald, Linwood, Davidson Co., N. C., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—The 18 carp received in February, 1881, and 10 received in March, 1882, I placed in 2 ponds covering, respectively, $\frac{1}{4}$ and $\frac{1}{2}$ acre, with depths of 4 and 7 feet, and muddy bottoms. A 2-inch flow of water, at a temperature in winter of 40° and in summer of 70°, supplies either pond.

PLANTS AND ENEMIES.—Flag and a few water-lilies grow in the ponds. A few frogs but no other fish inhabit it.

FOOD.—I give the carp bread, boiled corn, wheat, cucumbers, chopped melon rinds, and other vegetables.

GROWTH.—The 18 original carp are each larger than shad.

REPRODUCTION.—Though the carp did not spawn till 1883, the young are as large as a man's hand.

DIFFICULTIES.—I find it difficult to keep vermin out of the ponds.

MISCELLANEOUS.—I intend to construct other ponds this fall, and would be glad to get some leather and mirror carp.

543. *Statement of Robert H. Ricks, Rocky Mount, Edgecomb Co., N. C., Aug.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received on February 25, 1881, and 18 more subsequently, I put in a pond covering 12 acres. It has a muddy bottom, and a considerable amount of water in winter but little during the dry seasons. In summer the water is warm.

PLANTS AND ENEMIES.—Flag and grass grow in the pond. I have nearly exterminated the frogs and turtles, but a variety of creek fish still inhabit it.

FOOD.—I do not feed the carp.

GROWTH.—Seventeen months after the carp were put in the pond, I caught one that weighed 4 pounds.

REPRODUCTION.—The young are from 10 to 12 inches long.

DIFFICULTIES.—Mill-pond roaches give the carp more trouble than anything else.

544. *Statement of L. A. Thornburg, Dallas, Gaston Co., N. C*, *Sept.* 21, 1883.

DISPOSITION OF CARP RECEIVED.—I received 29 carp in April, 1880. My pond covers 4 acres, has a muddy bottom, and is 7 feet deep in the deepest part. A small creek flows through it. It is warm in summer and sometimes ice forms on it in winter.

PLANTS.—The pond contains a plant, which under the water is like moss, but when it comes to the surface has a small leaf.

ENEMIES.—There are perch and eels, turtles, frogs, and minnows in the pond. I have to-day moved the carp to a small pond which is free from other fish.

FOOD.—I have not fed them.

GROWTH.—I have all of the original lot, and they are about 2 feet long, weighing 8 pounds each.

REPRODUCTION.—I have seen 1 of the young which was 6 inches long.

545. *Statement of A. L. Darden, Contentnea, Greene Co., N. C., Sept.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—On February 28, 1881, I received 20 carp. I placed them in a mill-pond which covers from 5 to 7 acres, is from 1 to 3 feet deep, and has a muddy bottom. In winter a great quantity of water flows through the pond, but in summer a very little. Spring water flows through the pond except during a big rain.

PLANTS.—The pond contains willow trees but no grasses.

ENEMIES.—Bull-frogs, turtles, catfish, mullet, perch, and eels in small quantities inhabit the pond.

GROWTH.—Two of the original carp were about 28 inches long and weighed 10 pounds each.

EDIBILE QUALITIES.—We have eaten carp, some stewed, some baked, and some fried. All were pronounced of the very best by those who ate them. I think the carp in the finest fish that I ever saw, and has the finest flavor for eating. I prefer it stewed.

546. *Statement of James W. Albright, editor of the Daily Bugle, Greensborough, Guilford Co., N. C., May* 2, 1883.

GROWTH AND REPRODUCTION.—About two years ago last February, 18 carp about 4 inches long were placed in the Albright mill-pond, 2 miles north of this place. This pond was drawn yesterday and a wholesale capture of carp took place. Two old ones were captured, and the 1 shown us by Mr. J. E. McKnight measured 24 inches in

length, 16 inches around the body, and weighed 7 pounds and 2 ounces. The other was about the same size. There were 105 caught which weighed from 16 to 24 ounces, and measured from 10 to 13 inches in length. Several large ones are known to have escaped, and it is hoped they may stock the ponds lower down the stream.

Thus it will be seen that these fish spawn as early as 12 months of age, but when they cease to grow we know not.

547. *Statement of H. G. Ewart, Hendersonville, Henderson Co., N. C., Mar.* 20, 1884.

DISPOSITION OF CARP RECEIVED.—I placed the 40 carp, which I received December 15, 1881, in an extensive spawning pond, covering an area of 100 by 150 feet, with a depth of from 4 inches to 5 feet. I subsequently built hatching, nursery, and stock ponds. My hatching pond covers an area of 5 acres. It is fed by water from an adjacent spring, which is conducted in wooden troughs. The water in the pond is from 2 inches to 4 feet deep. Below this pond is the nursery pond, the depth of which varies from 2 inches to 6 feet, with a soil of black loam. The stock pond is situated ¼ of a mile from the nursery pond.

PLANTS.—The hatching pond is well supplied with needle grass, pickerel weed, water-lilies, wild rice, and other aquatics. The nursery pond also contains numerous aquatic productions.

ENEMIES.—Green frogs, musk-rats, turtles, snakes, cranes, herons, and kingfishers disturb the carp, and the only remedy is a shotgun, which must be used diligently and effectively during the summer months; otherwise the carp would soon be exterminated. I killed a blue crane which had swallowed whole a carp weighing 1½ pounds. The pond can be protected from poachers by stretching barbed wire under the surface of the water, close to the banks. This will soon put a stop to night seining.

FOOD.—Commencing in the spring, I daily give them lettuce leaves, turnip tops, and kitchen scraps. Later, I feed cabbage leaves, melon rinds, sweet corn, squash, &c., and in the fall pumpkins, boiled turnips, cabbage, potatoes, &c. They seem especially fond of pumpkins.

GROWTH.—I have carp weighing 5, 7, and 8 pounds which are only 3 years old, and 2 year-old carp weighing from 3½ to 4 pounds. In South Carolina, Georgia, or the eastern part of this State, where the waters are warmer, the fish would doubtless have attained a weight of 15 pounds. In this section, with long winter and late springs, they will not grow with such rapidity.

REPRODUCTION.—Last September I caught a female carp, weighing only 1¼ pounds, that must have had 20,000 eggs in it. A female carp weighing 5 pounds is said to contain 500,000 eggs. Unlike other fish, they do not spawn at certain seasons, but drop their eggs as soon as each female attains maturity, whether that be in April or November.

Just before the spawning season the carp evinces great activity. Naturally sluggish, it now swims rapidly through the pond, and often, like the mullet, jumps its entire length out of the water. When ready to deposit its eggs, the female carp heads rapidly for the warm, shallow water, closely pursued by the male. When the female drops her eggs, the male swims closely behind her, and dropping his milt among them vigorously lashes the water with his tail, mixing the spawn. This is the method of impregnation, and the eggs hatch in from 6 to 12 days, according to the temperature of the water.

EDIBLE QUALITIES.—Some carp were taken after the spawning season, late in the fall, and were plump and in good condition. I tried them baked and fried, and found them far superior in flavor to the mullet or perch, and very nearly, if not indeed quite, the equal of the shad. The flesh is very white, and is of about the same consistency as the latter fish.

The carp is as free from bones as any fish I know of. Indeed, with large carp, the bones give no trouble, the flesh flaking off nicely. Carp, however, should not be eaten during the spawning season, or immediately thereafter, as at that time, like all other fish, the flesh is soft and of an unpleasant taste. I do not believe, however, that carp taken from stagnant and offensive pools of water would be fit to eat; for, in such, the flesh of the fish will undoubtedly be affected and rendered unfit for table use, having a moldy and muddy taste.

HOW TO CATCH CARP.—The carp is not so gamy as the sheepshead, trout, or spanish mackerel, but it takes the hook freely at all times, is a strong puller and fights to the last. It often happened last fall that they snapped my line in two and escaped with bait and hook.

VITALITY.—Carp are wonderfully tenacious of life. Last September I caught a 2-pound carp, placed it in an empty bucket, and after a walk of ½ mile and a delay of at least ¾ of an hour, placed it in a tub of water. To my surprise in a few seconds it was as lively as when taken from the pond. I am now shipping breeders over the States, so far without loss.

DIFFICULTIES.—By committing the serious blunder of building cheap dams, the heavy freshets of 1882 swept my dams away, leaving me only a dozen or more of my carp. The 3 ponds which I subsequently built have been constructed on an improved plan.

FUNGUS.—I have been troubled but little with fungus. This is a moldy growth on the carp's back, caused by impure water, sometimes by wounds, often from a weak condition of the fish. There is no cure for it. Whenever it appears, the only thing to be done is to drain the ponds, kill all the diseased fish, and commence anew.

MISCELLANEOUS.—Whenever I ascertain that the carp are spawning, I examine the brush and twigs carefully, and transfer the branches covered with the eggs to the hatching pond, in which no fish are kept. Here they are placed in shallow water and carefully protected from frogs, turtles, &c., until hatched, when they are regularly fed with small particles of bread or cracker crumbs saturated in sweet milk. A trunk which extends through the dam is a pass-way for the small fry in the hatching to the nursery pond. The mouth of this trunk in the hatching pond is screened with galvanized wire mesh, large enough to admit of the passage of the little fry into the nursery, but too small to permit ingress to larger fish. In the nursery pond the hatch of this year will be allowed to remain until November, when the pond will be drawn, and the fry, then lively little fingerlings able to care for themselves, transferred to stock pond. This transfer is made by placing the young carp in 40-gallon barrels, and hauling them to the stock pond, where they have an unlimited pasture of about 75 acres in which to roam, and an inexhaustible supply of vegetable and insect life to fatten on. At a cost of $2,000, I have a most complete set of ponds, which, when the water is flush, cover 50 acres. I have three ponds—a nursery pond covering 2½ acres and a stock pond covering 45 acres, in addition to the spawning pond. All of these abound in aquatic plants.

548. *Statement of P. C. Carlton, Statesville, Iredell Co., N. C., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in December, 1880, and some subsequently. My pond contains 1 acre, and has an average depth of 1½ feet, with a bottom of alluvial soil. There is a flow of 1½ inches of spring water into it.

PLANTS AND ENEMIES.—It contains pond-lilies, wild rye, &c., and also a few frogs and turtles which I am trying to exterminate. Frogs, turtles, cranes, and musk-rats eat the spawn of carp.

FOOD.—I feed the carp with soft corn and mush twice weekly, sometimes 3 times.

GROWTH.—There are 12 or 15 of the original lot left. They weigh from 5 to 7 pounds.

REPRODUCTION.—They have produced a large number of young, which are from 2 to 12 inches long.

MISCELLANEOUS.—I consider the carp the best fish ever introduced into Southern waters.

549. *Statement of C. W. Alexander, Charlotte, Mecklenburg Co., N. C., Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in November, 1880. My pond covers ½ acre, has a muddy bottom, and is supplied from springs.

PLANTS.—An abundance of natural grasses grow about the pond.

ENEMIES.—There are quite a number of perch in the pond. I have succeeded in keeping the turtles caught out. I have tried to kill out everything but the carp.

GROWTH.—I have 19 of the original lot, and they will weigh from 5 to 7 pounds each.

REPRODUCTION.—I think the perch destroyed the spawn, as, when I drew off the pond last fall, I found at least 3 bushels of perch.

550. *Statement of W. W. Grier, Charlotte, Mecklenburg Co., N. C., Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—The 40 carp received in November, 1880, I placed in an artificial pond covering about ½ acre, with a depth from 18 inches to 4 feet, and a muddy bottom. A moderately cool spring supplies the pond with water.

PLANTS.—Cresses grow in the pond, and ordinary meadow grasses along the banks.

ENEMIES.—Frogs and turtles in abundance, but no other fish inhabit the pond.

FOOD.—I give the carp scraps of fresh meats, rabbit-meat, and different kinds of coarse food.

GROWTH AND REPRODUCTION.—I think there are 36 old carp remaining. I can give no idea of the number of young. One measured 14 inches in length.

DIFFICULTIES.—I have not given the carp the attention they should have received. I find it difficult to rid the pond of the frogs and turtles.

551. *Statement of S. P Blankenship, Pineville, Mecklenburg Co., N. C.*, 1883.

FOOD.—I have received in all 60 carp. I feed them on boiled rice, wheat, peas, and scraps from the table.

REPRODUCTION.—I cannot count the young, but they are very numerous. I expect to have an abundance of fish for my table another year, even in my small pond.

552. *Statement of David Farlow, Level Plains, Randolph Co., N. C., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received about 20 carp in March, 1881. My pond covers about ½ acre, and has an average depth of about 2 feet, and a muddy bottom. A strong spring branch supplies the pond with water.

PLANTS AND ENEMIES.—Weeds and a coarse grass grow in the pond. Bull-frogs and branch minnows, but no other fish inhabit it.

FOOD.—Irregularly, I feed the carp on bread.

GROWTH.—There are from 3 to 4 old carp remaining, and these average 16 inches in length, and from 2 to 3 pounds in weight.

REPRODUCTION.—There are perhaps 1,000 of last year's young in the pond, and these are from 8 to 10 inches long, and weigh from ½ to 1 pound.

DIFFICULTIES.—Poachers visit the pond.

553. *Statement of P. N. Stanback, Little's Mills, Richmond Co., N. C., Oct.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received 80 carp in November and December, 1879, and 14 in February, 1883. My pond is 45 by 70 feet, of muddy bottom, and 7 feet deep. It is amply supplied with spring water at all seasons. It never gets hot.

PLANTS.—There is a fringe of grass, rushes, &c., around the border.

ENEMIES.—There are a few perch, a few frogs, but no turtles.

FOOD.—I feed them two or three times a week on cooked bread. They became very gentle last summer, and would come readily to their food.

GROWTH.—Those that have not been fished out by thieves are about 12 to 14 inches long.

REPRODUCTION.—There are a few young which are 4 or 5 inches long.

DIFFICULTIES.—The only difficulty has arisen from the very thievish negroes, who could doubtless inform you about their edible qualities. I cannot eat any because I have been too eager to propagate them.

MISCELLANEOUS.—I have prepared 3 ponds, with an aggregate length of 320 feet, 50 feet width, and inclosed with a paling 7 feet high. I surmounted it by a strand of barbed wire. I stocked the first pond with perch and redhorse, which did finely but for the negroes. Some of them had attained the weight of from 6 to 9 pounds, but I lost them all in one day. The carp grew finely as I fed them bountifully with bread every day, so that from December to June they had attained a size of from 10 to 12 inches, and came regularly to their feeding-place. This pleased me so much that I showed them to many friends, and one day a few negroes were admitted to see the sight. Shortly afterward the carp failed to be seen basking in the shade of the bridge over the pond. I have raised the barbed-wire fence, and am going to try it again.

554. *Statement of W. R. Fraley, Salisbury, Rowan Co., N. C., Sept.* 8, 1882.

GROWTH.—I received on the 8th of December last, 20 mirror carp about 3 inches long, which would have weighed probably about ½ ounce each. Since then I have weighed and measured them at various times, with the following results, to wit:

	Length.	Width.	Weight.
1882. May 20	9½ inches.	3½ inches.	1 pound.
June 20	12½ inches	4¼ inches.	2 pounds.
July 20	14½ inches.	4¾ inches.	2¼ pounds.
August 15	16½ inches.	5 inches.	3 pounds.

555. *Statement of W. F. Watson, Salisbury, Rowan Co., N. C., Aug.* 10, 1882.

GROWTH.—On April 1, I received a lot of carp measuring from 2½ to 3 inches in length and weighing about ½ ounce each. On August 3 one of these fish measured exactly 12⅝ inches in length, 4½ inches in width, and weighed 1½ pounds. The fish was fine and fat and very active.

556. *Statement of Samuel H. Hand, Reidsville, Rockingham Co., N. C., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—The 25 scale carp received in March, 1881, I put in a pond 25 by 60 yards, with a depth varying from 2 to 7 feet. The water that flows into the pond is temperate and clear.

PLANTS.—Cat-tails grow in the pond. It contains nothing that disturbs the carp.
FOOD.—I give the carp refuse from the table.
GROWTH.—The 25 original carp vary in weight from 1½ to 2¼ pounds, and are hearty. I have seen no young yet.

557. *Statement of Oliver Hicks, Rutherfordton, Rutherford Co., N. C., Oct.* 28, 1882.

VALUE.—I would not take $500 for the prospect my carp pond now offers.

558. *Statement of M. R. Banner, Walnut Cove, Stokes Co., N. C., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp October 13, 1880. My pond covers ¼ of an acre, is 8 feet deep, and has a muddy bottom. It is supplied with water from a small spring branch, the mean temperature of which in summer is about 80°.
PLANTS AND ENEMIES.—It contains a few weeds, vines, and rushes. Some frogs and one muskrat found their way into it.
FOOD.—Once a week I give them ears of corn and corn-bread baked without sifting.
GROWTH.—The 6 of the original lot which I had left were 16 inches long on the 14th of last September, at which time carp pond and all were washed away.
REPRODUCTION.—There were a good many young there in 1882, but they were very small.

559. *Statement of Jos. A. Haywood, Raleigh, Wake Co., N. C., Feb.* 23, 1884.

GROWTH.—The mirror carp which I received from the Government in 1882 now weigh from 10 to 15 pounds each.

560. *Statement of S. G. Worth, Supt. Fisheries, Raleigh, Wake Co., N. C., Oct.* 25, 1883.

GROWTH.—Messrs. Joe and J. Pugh Haywood, of Raleigh, drew off their pond 2 weeks ago and found 16 three-year-old fish, the smallest was 12 and the longest 15 pounds in weight.
A letter from Jacob E. Masters, of Red Hill, Mitchell County, yesterday, reports a carp, measured with a square, 19 inches long, thick and broad in proportion. He secured the fish this year, and in March they were only 4 inches long. Mitchell is one of our highest and coldest counties, containing mountains more that 5,000 feet high.
EDIBLE QUALITIES.—Dr. D. W. C. Benbow, of the Benbow House, Greensborough, bought 11 carp a few days ago and served them for breakfast to his guests. They were on the bill of fare, and all who ate with one accord pronounced them excellent.

561. *Statement of W. K. Hunter, Rolesville, Wake Co., N. C., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received on March 6, 1881, I put in a pond covering about 1 acre, with a depth of 5 feet, and a muddy bottom. A stream of 4 square inches, colder than ordinary branch water, flows into the pond.
PLANTS AND ENEMIES.—Oat-hay, or grass, grows in the pond. A few bull-frogs, but no other fish than carp inhabit it.
GROWTH.—The 18 carp remaining average 4 pounds in weight.
REPRODUCTION.—The 200 young vary in length from 3 to 7 inches.
DISPOSITION OF YOUNG.—I have stocked 5 ponds larger than the one in which the original carp are kept.

OHIO.

562. *Statement of George Weedman, M. D., Nova, Ashland Co., Ohio, Aug.* 7, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 carp received in November, 1880, I put in a pond covering about ¾ acre, with a depth of from 7 to 10 feet, and a bottom composed of sand and gravel. Pure spring water feeds it.
ENEMIES.—Black bass and sun-fish are found in the pond.
FOOD.—I give the carp light bread and crackers about twice a week.
GROWTH.—I caught a carp in March which was 15 inches long. I saw one this evening that appeared to be nearly 18 inches in length.
REPRODUCTION.—When the water is still, great numbers of young can be seen. The pond is well supplied with them.
DIFFICULTIES.—I have no means of draining the pond.

563. *Statement of J. V. Brown, Conneaut, Ashtabula, Co., Ohio, July* 30, 1883.

DIFFICULTIES.—Although the 15 carp received on November 9, 1880, were in good condition when they went into their first winter quarters, they were all destroyed before the following spring by minks.

564. *Statement of the Athens Asylum for the Insane, Athens, Athens Co., Ohio, Dec.* 14, 1883.

DISPOSITION OF CARP RECEIVED.—In the spring of 1881 we received about 1 dozen carp. In the year 1882 we received 2 lots of about 1 dozen each, and received in October, 1883, another lot. We kept the carp in a chain of artificial lakes of about 16 acres in area, puddled with clay and covered with sand and stones for spawning. The average depth of the water is 5 feet. In addition to the supply of water received from springs, water is pumped into the lakes from the Hocking River through 6-inch pipes. The temperature of the water is that of the surrounding atmosphere, but varies in parts by being fed by the water from the springs.

PLANTS.—Mosses, water-grass, sweet-water algæ, and pond-lilies are found in the lakes.

ENEMIES.—The pond contains frogs, catfish, sun-fish, and it is partially stocked with bass. Efforts were made to rid the lakes of all the fish except the bass.

FOOD.—We gave the carp no food artificially.

GROWTH.—A carp caught last spring weighed 1½ pounds.

REPRODUCTION.—We cannot tell the number of young produced.

565. *Statement of August Sourd, Fayetteville, Brown Co., Ohio, Sept.* 11, 1884.

GROWTH.—I received German carp in November, 1882. They are now 2 years old and weigh 6½ pounds. They have not spawned yet.

566. *Statement of Samuel Gillespie, Millville, Butler Co., Ohio, Dec.* 14, 1882.

DISPOSITION OF CARP RECEIVED.—When I received the carp November 7, 1881, they were about 2 inches long. After putting them in the pond I saw nothing of them until the 15th of June.

FOOD.—I then commenced feeding them twice a day on bread and potatoes. I continued this until the middle of July; then I commenced on sweet corn cut from the cob. They are very fond of this, and come as readily for it as my pigs. I still fed the scraps from the table, too, but corn is their favorite.

GROWTH AND HIBERNATION.—My fish surpass all expectations in growth. They are estimated by the most competent judges to weigh 4 pounds. On the 16th day of November they bade me adieu until next summer. They have caused quite an excitement, and people come miles to see them.

567. *Statement of Andrew Phillip, Kilgore, Carroll Co., Ohio, Aug.* 4, 1884.

DISPOSITION OF CARP RECEIVED.—The 18 carp received in November, 1880, I put in a pond covering about ⅛ of an acre, and having a muddy bottom. It is fed by 2 or 3 springs of moderately cool spring water. The pond contains no plants, but there are many frogs and turtles in it. I did not feed the carp.

DIFFICULTIES.—My pond is not adapted to carp culture, and, besides, such enemies as the turtle and snake are too numerous for them. None of the carp remain.

568. *Statement of Kemp Gaines, Springfield, Clark Co., Ohio, Nov.* 28, 1881.

FOOD.—The carp I received in November, 1880, were only from 2 to 3½ inches long, and I do not think the largest would have weighed more than an ounce. As the pond was so rich in food for carp, I did not deem it necessary to feed the carp regularly. It is true that food was sometimes given them, but it was done only to ascertain what they were fond of. I have fed water-grasses which grow around the pond, purslane, cut cabbage, boiled potatoes, and green sugar-corn. They seemed to relish all that we gave them, but showed a decided preference for the green corn, sliced from the ear. Any warm day I could bring the carp to the surface of the water by slicing some green corn in the water near the edge of the pond. Within from 2 to 5 minutes, from 10 to 15 of the 20 carp could be counted, their backs being out of the water. I do not know by what means they discovered in so short a time that the corn was in the pond.

GROWTH.—By the means of a dip-net I succeeded in taking from the pond in the last week in August 3 scale carp. They measured, respectively, 13, 14, and 15 inches, and

weighed $1\frac{3}{4}$, $2\frac{1}{4}$, and $2\frac{1}{16}$ pounds. The last part of October I caught in the same way a leather carp which was 18 inces long and weighed 2 pounds. I am satisfied that there are now fish in my pond which will weigh between 3 and 4 pounds, though not over 18 months old. Scale carp, being the more bulky fish, outweigh leather carp.

REPRODUCTION.—I think the carp spawned to some extent about the middle of last August, though I have seen no young. This, I think, is due to the fact that the pond has a bottom of clay and marl which gives the water a yellowish tint, thereby rendering it impossible to see small fish unless they be very near the surface. Since seeing my carp, quite a number of people have engaged young fish of me.

MISCELLANEOUS.—If the same interest which is now manifested among the farmers continues to exist, Ohio, in a few years, will be largely supplied with a cheap and wholesome food, produced from waste lands not heretofore utilized.

569. *Statement of Kemp Gaines, Springfield, Clark Co., Ohio, Dec.* 11, 1882.

GROWTH AND REPRODUCTION.—When I drained my pond this fall I found that I had lost but 1 of my carp, having 19 old fish living which weigh from 4 to 6 pounds each. About $\frac{1}{3}$ of the young fish hatched last spring and summer are from 6 to 7 inches long. By feeding them regularly they will grow much larger in the same length of time. I let one of my neighbors have 48 young fish from 2 to 4 inches in length, on the 20th of July, 1882. He fed them scraps from the table most every day. The 1st of November he drained his pond to stop a leak in the embankment and took the fish out. I was present and measured several myself. None were less than 8 inches, and many of them 12 inches long.

Sixteen applicants who did not get their ponds ready this fall expect to stock them next summer. If I still have good luck I think I will be able to fill all applications I may get another year. I have separated my scale and leather carp, thinking they will do better.

DISPOSITION OF YOUNG.—During the summer and fall I have furnished young carp for stocking 23 ponds with from 2 to 5 dozen fish to each pond. I have kept over 300 for stocking 2 ponds of my own which I constructed the past summer. [See also above.]

570. *Statement of Kemp Gaines, Springfield, Clark Co., Ohio, Nov.* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 10 scale carp and 10 leather carp. I have kept them in 2 artificial ponds covering about 1 acre each. The bottom is composed of mud and marl and the greatest depths are 5 and 6 feet. About as much water flows through the ponds as could be carried in a $2\frac{1}{2}$-inch pipe. The temperature is about that of river water after the stream reaches the ponds.

PLANTS.—The bottom of each pond is covered with a kind of moss that grows in boggy mill-races, and the edges with different kinds of water-grasses.

ENEMIES.—There are no other fish, but there are plenty of frogs and toads in summer. There are also a few muskrats which cause trouble by burrowing in the embankments.

FOOD.—I feed the carp with green corn.

GROWTH.—I have 16 of the original lot still left; 8 scale and 8 leather. They are all about the same size. I weighed several when I drained the ponds this fall and found them to weigh $7\frac{1}{2}$ and 8 pounds.

REPRODUCTION.—About 4,000 young have been produced. Those 1 year old weigh from $1\frac{1}{2}$ to $2\frac{1}{4}$ pounds, and the young fish are from $2\frac{1}{2}$ to 6 inches long.

DISPOSITION OF YOUNG.—I stocked 22 ponds last season with young carp and 24 ponds this season, and I still have several applications to fill. I supplied from 3 dozen to 10 dozen carp to each of the 24 ponds, and for each of the 18 of the 24 ponds stocked this season I furnished 5 or 6 yearling fish (3 males and 2 females) that will spawn next spring—over 100 in all. I have thus far supplied ponds in 5 different counties in my own State, and have 300 small and 40 yearling carp remaining for my own use.

EDIBLE QUALITIES.—During the summer quite a number of my neighbors and friends have eaten carp at my house, and their opinion as to superiority was about equally divided between the leather and scale varieties, which I had fried separately. Either of the kinds is equal to any of our river fish, bass not excepted.

HOW TO DISTINGUISH THE SEXES OF CARP.—I find that the key to this problem is in the form of the head of carp. I always examine the heads of carp taken for table use, and in but one instance have I been mistaken as to the sex of the fish thus examined.

571. *Statement of S. Miller, Felicity, Clermont Co., Ohio, Nov. 2, 1883.*

GROWTH.—I received through your agent, Frank N. Clark, of Northville, Mich., 20 carp, of last year's spawning, on March 8, 1883. After putting them in a pond I did not see them until the latter part of May. I soon after began to feed them and they became quite tame and grew very rapidly, so that by September 1 they were half as long as a man's arm, and would weigh fully 5 pounds each. About this time they went into winter quarters. The farmers in this section are wild over fish-ponds.

572. *Statement of W. J. Quarry, Felicity, Clermont Co., Ohio, Dec. 1, 1882.*

GROWTH.—The fish Mr. R. T. Adams received last December are doing nicely, and will weigh from 4 to 5 pounds.

573. *Statement of John H. Abrams, Moscow, Clermont Co., Ohio, Oct. 16, 1883.*

DISPOSITION OF CARP RECEIVED.—Last March Mr. Prickett received 20 carp, the largest not more than 2½ inches long. He lost all but 3 in a freshet. These remained in a shallow pond until the middle of August, when they were found to measure 11½ inches in length.

574. *Statement of G. W. Prickett, Moscow, Clermont Co., Ohio, Dec. 4, 1883.*

DISPOSITION OF CARP RECEIVED.—The fish I received from you last winter I had in my pond, but the dam broke and I lost all but 2. The breaking was caused by too much surface water running into it. I have since built a race-way that leads all the water around the pond.

GROWTH.—The carp when received were about 3 inches long. Five months later I drained the pond and caught 2 fish that measured 11 inches each. I think this pretty good growth for 5 months.

575. *Statement of Leo Weltz, Wilmington, Clinton Co., Ohio, July 28, 1883.*

DISPOSITION OF CARP RECEIVED.—The 12 carp received in the spring of 1882 I put in a pond covering about ½ acre, with a depth of from 6 to 8 feet, and a bottom composed of clay. The temperature of the pond varies from 50° to 75°. It is fed by a bold spring.

PLANTS.—Various kinds of algæ and moss grow in the pond; and shade-trees on the banks, which are soddy. Nothing that disturbs the carp inhabits the pond.

FOOD.—About twice a week I feed the carp on liver, and ground corn made in small balls, and sometimes give them chicken refuse.

GROWTH.—The original carp will weigh about ½ pound.

576. *Statement of S. O. Hawkins, Bucks, Columbiana Co., Ohio, Aug. 20, 1883.*

DISPOSITION OF CARP RECEIVED.—The 17 carp received on November 15, 1880, and 40 subsequently, I put in a pond 20 by 100 feet, with a depth of 3 feet, and a bottom of gravel. The dam broke and allowed the carp to escape into a creek, where they are now rapidly breeding. I have caught and eaten several of them. The water in it is very cold, and is quite swift. If I can get more carp, I will make another pond to cover ¾ acre.

577. *Statement of Theodotus Garlick, Bedford, Cuyahoga Co., Ohio, July 28, 1883.*

DISPOSITION OF CARP RECEIVED.—We received 15 scale carp in 1881, and 50 mirror through Mr. E. D. Potter, Toledo, Ohio, in 1882. We put the mirror carp in a ¼-acre pond, with a mucky bottom. It is supplied with water from a swamp that is fed by never-failing springs.

PLANTS.—Water-lilies (*nymphæa odorata*) grow in the pond. It will shortly be stocked with wild celery (*vallisneria spiralis*).

ENEMIES.—We try to destroy the frogs which inhabit the pond. It contains no other fish than carp.

FOOD.—Irregularly, we feed the carp on wheat and refuse from the table.

GROWTH.—The mirror carp weigh about 1 pound, the scale less, as they have been kept in much cooler water. There are 11 of the original scale carp remaining.

REPRODUCTION.—There is a plenty of young, which, being lately hatched, are very small. Carp are raised as easily here as poultry.

MISCELLANEOUS.—Next spring Mr. Leverett Tarbell, whom I have associated with me, and I will construct a 1-acre pond and from 1 to 2 small spawning and hatching ponds. As I think wild celery (*vallisneria spiralis*) a suitable plant for the carp to feed and deposit their eggs on, we will stock the pond with it, and also with wild rice. It will not be many years before carp culture will be a common occupation here. We have an abundance of water especially adapted to them.

578. *Statement of Henry W. Elliott, Cleveland, Cuyahoga Co., Ohio, Nov.* 1, 1883.

ENEMIES.—My neighbor on drawing off his pond and finding only one large carp instead of the hundreds he should have had, and discovering 7 or 8 muskrat holes in the banks, concluded that muskrats were the cause of the destruction and disappearance of the fish. I have since learned that carp ponds in Virginia, Pennsylvania, and Illinois have been robbed and the fish destroyed by muskrats. The attention of fish-culturists should be quickly drawn to this danger, and the prompt destruction of the muskrats may save much loss in the propagation of carp and goldfish. His nocturnal habit in feeding renders trapping the only practicable method by which to get rid of this pest. The hog-like character of carp in plowing up the bottom and banks of the pond, thereby keeping the water muddy and rendering themselves invisible, enables the entrance to the muskrat's burrow to be concealed until the water is drawn off. The fry and older carp stupidly poke themselves into these burrows, thus making themselves an easy prey. When ice forms, and the carp settle numb and torpid to the bottom, then, in my opinion, the ravages of the muskrat are most to be feared by the fish-culturists; but before that time he should get rid of these pests.*

579. *Statement of J. J. Stranahan, Chagrin Falls, Cuyahoha Co., Ohio, Oct.* 31, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 carp received on November 5, 1880, I gave to Mr. W. E. Walters, who lives 1½ miles from this place. He has a very fine pond, and agrees to furnish free for stocking purposes all who may desire young. He also received a lot in 1881.

GROWTH AND REPRODUCTION.—We had only got about 150 carp out of our pond when, owing to the caving in of the outlet, the work of netting had to be stopped. Those we distributed were very fine, 4 or 5 inches long and, say, 1½ to 2 inches wide; and we think they were all this year's hatch, as we caught no small ones, although our net had a very small mesh. Some of the old fish—the oldest are not over 3 years old—weighed 5 pounds apiece.

MISCELLANEOUS.—Dozens of farmers are constructing ponds for the young that they will receive from Mr. Walters. We expect to have a fine display of carp at our county fair this fall.

EDIBLE QUALITIES.—Mr. Walters caught a scale and mirror carp, and pronounced their edible qualities to be superior to whitefish.

580. *Statement of B. Raney, Franklin Square, Columbiana Co., Ohio, Sept.* 5, 1882.

GROWTH AND REPRODUCTION.—I procured a supply of carp last fall and this spring. They now weigh from 2½ to 3¼ pounds. They spawned in June, July, and some in August. I think I have about 50,000 young, the most of which are from 3 to 5½ inches long. The fish obtained last November, 1881, were from 2 to 3 inches long.

581. *Statement of G. W. Armstrong, New Lisbon, Columbiana Co., Ohio, Aug.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 carp received in the fall of 1880, and the 20 received in 1882, I put in an ⅛-acre pond, having a maximum depth of 7 feet, and a muddy and mucky bottom. A continual 1 inch stream of moderately cool water feeds the pond. In summer the water gets very warm.

PLANTS AND ENEMIES.—Water-lilies and other water plants grow in the pond in great numbers. A few turtles have gotten into the pond.

GROWTH.—Each of the 20 original carp remaining weigh about 5 pounds. They have not spawned yet.

582. *Statement of Charles Gamble, Salem, Columbiana Co., Ohio, July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1880, I received 14 carp, which, however, were soon destroyed by the freezing of the water in which I placed them. The second lot, received in the fall of 1882, I kept, during the winter, in a 4-gallon stone

* For fuller account and mode of capture see U. S. F. C. Bull., 1884, p. 296.

vessel, changing the water once in 48 hours. In the spring of 1883 I put them in a pond that is fed by a spring, having a temperature of 48°.

PLANTS AND ENEMIES.—Calamus and peppermint grow in the pond. Frogs and water-snakes only are also found in it.

FOOD.—From 2 to 3 times a week I give the carp wheat-bread and crackers.

MISCELLANEOUS.—I still have 10 or 12 of the 1882 lot, but have not seen them but once or twice this summer.

583. *Statement of Timothy Gee, Salem, Columbiana Co., Ohio, Oct.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received 12 carp in November, 1880, and 20 more in November, 1881. I kept them in a pond 160 by 180 feet, with a muddy bottom, and with water 2 to 6 feet deep.

PLANTS.—It contains white pond-lilies.

ENEMIES.—It contains no other fish, but it has some frogs.

FOOD.—Twice a week I give them corn-meal, wheat bran, corn-bread, and celery.

GROWTH.—I still have four of the first lot and ten of the second lot. The first weigh from 8 to 10 pounds each. One of the second lot when dressed weighed $2\frac{1}{2}$ pounds.

REPRODUCTION.—The young are from 2 to 10 inches long, and the pond seems to be full of them. I am offering young for sale now.

EDIBLE QUALITIES.—The family has cooked one or two carp, and think them very fine.

MISCELLANEOUS.—I was walking around my pond in February, 1882, and greatly to my surprise I saw 4 fish, that appeared to be from 12 to 16 inches long, sunning themselves upon the surface of the water. They frequented the same place every day for about 3 weeks, after which I did not again see them for 2 months. Since then I have seen them swimming on the water, and after rains they can be seen jumping 2 or 3 feet above the water. Our pond has proved a great pleasure to our friends as well as to ourselves.

584. *Statement of Rush Taggart, Salem, Columbiana Co., Ohio, July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The carp received in November, 1880, and spring of 1882, I put in a pond 100 by 125 feet, with a depth varying from 3 to 10 feet. It has a temperature of from 50° to 60°, and it is fed only by springs in the pond. No plants grow in the pond, and it contains nothing that injures or destroys the carp.

GROWTH.—In the winter of 1882–'83 the original carp averaged nearly 3 pounds.

DIFFICULTIES.—Muskrats drained my pond in the winter of 1882–'83 and caused the loss of the carp.

MISCELLANEOUS.—I desire to get my pond again stocked with carp. Carp are being raised with great success in small ponds in this immediate neighborhood.

585. *Statement of H. R. Pardee, Strongsville, Cayahoga Co., Ohio, Aug.* 11, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 carp received in November, 1880, I put in a half-acre pond, having a depth of 4 feet and a muddy bottom. Enough spring water flows into the pond, which is adapted to carp culture, to keep it clear and cool. The discharge water is carried off by means of a raceway around the pond.

PLANTS AND ENEMIES.—Lilies, cat-tail flags, and sea-grass roots, or moss grow in the pond. Bull-heads, frogs, and turtles inhabit it.

FOOD.—I give the carp lettuce, cabbage, and meal to toll them into sight, but I have not succeeded.

REPRODUCTION.—Last spring I found 2 small fish that washed through the sluice, which I supposed were carp. They were lodged in the grass, and were each 5 inches long.

MISCELLANEOUS.—Although I have been unable to see any of the carp, I believe they are in the pond. I fished for them with a hook, but got no bite.

586. *Statement of Samuel Gamble, Winona, Columbiana Co., Ohio, Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—I put the 13 carp received in the fall of 1880 in a pond, 1 by 8 rods, with a depth of from $1\frac{1}{2}$ to $2\frac{1}{2}$ feet, and supplied with water by a small spring.

ENEMIES.—Frogs infest the pond, and a turtle was also found in it.

DIFFICULTIES.—The ice on the pond was 12 inches thick in the spring of 1881, when the dam broke and lowered the water to a depth of 12 inches. I have not seen the carp since.

587. *Statement of Gustin Havens, Lewis Centre, Delaware Co., Ohio, Aug. 8, 1883.*

DISPOSITION OF CARP RECEIVED.—The 20 carp received December 7, 1880, I put in a ¼-acre pond, with a maximum depth of 10 feet and a muddy bottom. It is supplied with a flow of surface water mostly, which during the spring and fall will fill a 2-inch pipe. No water flows into the pond in summer, unless it is very wet. Half of it is shallow.

PLANTS.—Pond-lilies, sweet-flag, and various kinds of swamp-grass and weeds grow in the pond.

ENEMIES.—Frogs and an occasional turtle are found in the pond. No other fish than the carp inhabit it.

FOOD.—In addition to the daily allowance of bread, mill-feed, and corn-meal mush, I give the carp food whenever visitors come. They became quite tame at last, and would eat from the hand and allow us to handle them at pleasure.

GROWTH.—In the fall of 1882, 2 carp weighed, respectively, 5½ and 6 pounds. There are 17 original carp remaining which will average from 5 to 8 pounds.

REPRODUCTION.—The yearling are from 6 to 12 inches long, and this year's young are from 1 inch to 2 inches long. They spawned in June, 1882, stocking the pond with young which were from 4 to 8 inches long before winter.

SALES.—I have sold 32 dozen young to stock other ponds.

EDIBLE QUALITIES.—Thinking my pond well stocked, I took out last fall 2 of the old fish to test them as a food-fish. They were 22 and 23½ inches long and weighed 5½ and 6 pounds, respectively. A good judge of fish pronounced them equal in quality to the best creek bass.

DIFFICULTIES.—As I have but one pond, the young fish eat many of the eggs. I purpose providing drainage to the pond I shall build, and shall separate the carp.

588. *Statement of Solomon Boyer, Norton, Delaware Co., Ohio, Aug. 1, 1883.*

DISPOSITION OF CARP RECEIVED.—The 20 carp I received on December 1, 1881, I put in a half-acre pond having a depth of 5 feet and a muddy bottom. Twenty-two acres of land serve as a watershed for it. The water is warm.

PLANTS.—Cat-tail and a 3-cornered rough-bladed grass from 2 to 3 feet high grow in the pond.

ENEMIES.—Only a few green frogs and small turtles inhabit the pond.

FOOD.—Daily I give the carp potatoes, corn, bread, scalded milk, and the refuse from the table in small quantities.

GROWTH.—The original carp are from 18 to 24 inches long, and weigh from 4½ to 8 pounds. I have 16 of them. The leather carp are the largest.

REPRODUCTION.—The young are from 10 to 13 inches long, and weigh from 1½ to 2 pounds.

589. *Statement of Joseph Bechtel, Amanda, Fairfield Co., Ohio, Sept. 16, 1882.*

FOOD.—My carp eat boiled corn, potatoes, beans, milk, and bread.

GROWTH.—I received 24 carp, which are all alive. They measure from 12 to 14 inches in length and weigh from 1½ to 1¾ pounds. They are lively.

MISCELLANEOUS.—I cannot say enough in behalf of this new industry. I think every man who has a marshy or wet place would do well to give attention to the cultivation of carp. I am making another pond.

590. *Statement of George L. Converse, Columbus, Franklin Co., Ohio, Oct. 12, 1882.*

DISPOSITION OF CARP RECEIVED.—My constituents of the Columbus (Ohio) district are very desirous for carp. Those you sent me last year were carefully distributed and are doing well. I put them into a small pool, 3 by 8 feet, 2 feet deep, and, as they were called for, I took them out with a net.

591. *Statement of J. L. Stelzig, Supt. City Park, Columbus, Franklin Co., Ohio, July 31, 1883.*

DISPOSITION OF CARP RECEIVED.—The 24 carp received in 1881 we put in a pond, 80 by 120 feet, with a depth of 6 feet and a bottom of clay. It is fed by a half-inch stream of water.

PLANTS.—Nymphæa alone grows in the pond. No enemy of the carp inhabits it.

FOOD.—We give the carp bread and cheese daily, and potatoes weekly.

GROWTH.—The 15 carp remaining are from 18 to 24 inches long and weigh from 2 to 3 pounds each.

REPRODUCTION.—There are probably 100 young in the pond, which are from 2 to 12 inches long. They are 1 year and 2 years old.

DISPOSITION OF YOUNG.—We removed the young to a half-acre artificial lake.

592. *Statement of L. W. Budd, Dublin, Franklin Co., Ohio, Oct.* 12, 1881.

GROWTH.—November 22, 1880, I received 20 carp, measuring from 2 to 4 inches. On October 10, 1881, I drew off the water from my pond to rid it of catfish, and found that my carp had grown enormously and were almost of one size. Two measured, respectively, 16 and 17½ inches in length and weighed 3½ and 4 pounds.

REPRODUCTION.—[Under date of January 8, 1883, Mr. Budd states that his carp spawned in 1882.—EDITOR.]

593. *Statement of H. C. Tuttle, Burton, Geauga Co., Ohio, July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received in the fall of 1881 I put in a pond covering about 2 acres, with a maximum depth of 10 feet and a muddy bottom. I subsequently received 60 more. As the carp in the pond died before the spring of 1882 I kept 20 in a tub in a cellar last fall, but they died also. The 24 that I bought this spring are doing well.

PLANTS.—Plants indigenous here grow in the pond. Nothing that disturbs the carp inhabits it.

FOOD.—I give the carp chopped liver and other food.

594. *Statement of M. R. Parsons, Chardon, Geauga Co., Ohio, July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 carp received in November, 1880, I kept in a spring as my pond was frozen over until April, 1881. I also received 15 in the fall of 1882, which I put in the 1-acre pond with a depth of from 4 to 6 feet and a muddy bottom. The rain water, which alone supplies the pond, is warm and clear in summer.

PLANTS AND ENEMIES.—Lilies and other water-plants on which the carp feed grow in the pond. Turtles and frogs are also found in it.

FOOD.—I do not feed the carp.

GROWTH.—The 8 carp which I put in the pond in the spring of 1881, I saw nothing of till the spring of 1883, when I found 7 of them dead. The pond was frozen over from November until April. The carp averaged 20 inches in length and weighed from 4 to 6 pounds. I have seen no young yet.

595. *Statement of James Cullen, Sec. Cincinnati Ice Co., Cincinnati, Ohio, July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—In each of the winters, 1881, 1882, and 1883, I received 20 carp which I placed in 3 ponds, respectively 10, 20, and 30 acres, having an average depth of 5 feet and muddy bottoms. Canals supply the ponds with water, the amount of which depends upon the weather.

PLANTS AND ENEMIES.—Grass and moss grow in the pond in large quantities, and sun-fish, catfish, and turtles inhabit it in considerable numbers.

FOOD.—We have not fed the carp, supposing the ponds contained a plenty.

GROWTH.—We are satisfied that some large carp are in the pond, but have never caught any.

596. *Statement of Hugo Mulertt, Cincinnati, Hamilton Co., Ohio, July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The 13 mirror and 9 scale carp received in the fall of 1880, I put in a pond especially constructed for the purpose, 16 by 30 feet, with a depth varying from 6 to 24 inches and a bottom of rich black soil. About 1 gallon of water at an average temperature of 75° F. flows through the pond per minute. The carp hibernate in a deeper pond.

PLANTS.—Abundance of *anacharis canadensis*, *ceratophyllum demersum*, 3 kinds of *nymphæa odorata*, and duck-weed (*lemnæ*) grow in the pond. The carp are delighted with the latter.

ENEMIES.—There are also 20 grass bass (*pomoxys hexacanthus*) in the pond.

FOOD.—I do not feed the carp.

GROWTH.—The 5 mirror and 5 scale carp remaining average 4 pounds in weight.

REPRODUCTION.—I have raised a great many young. I find that they will attain the first season, without food, a length of from 3 to 6 inches, and at the end of the second year will weigh 1¼ pounds.

DISPOSITION OF YOUNG.—I sold and gave away the young.

DIFFICULTIES.—I lost 8 mirror and 4 scale carp. Muskrats disturb the carp when in winter quarters.

MISCELLANEOUS.—The German carp will become a favorite dish with the Americans as soon as they learn how to prepare it for the table.

597. *Statement of Wm. Salway, Supt. Spring Grove Cemetery, Cincinnati, Ohio, Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—The 17 carp received by Mr. Adolph Strauch, late superintendent Spring Grove Cemetery, were placed in a pond covering 5,000 feet of area, with an average depth of 2 feet and a gravelly bottom. The supply of water is small and is moderately cool. There are no plants in the pond.

ENEMIES.—Swans and frogs are to be found in the pond.

FOOD.—I give them bread every day.

GROWTH.—On July 14, I caught 2 carp which weighed 3 pounds each.

MISCELLANEOUS.—I have not been in charge of the pond sufficiently long to know the number of original carp remaining, nor whether there are any young in the pond.

598. *Statement of H. W. C. Muth, Mt. Healthy, Hamilton Co., Ohio, Dec.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—In the latter part of the year 1880 I received 40 German carp. The bottoms of my ponds are of a clay soil; depth, varying from 8 to 12 feet in the deepest parts, the water getting shallower as it approaches the shores. Each of the ponds covers an area of less than an acre. These ponds are supplied with water from the surface, springs, and small streams. The ponds contain no water-plants nor grasses.

ENEMIES.—Snapping-turtles and various kinds of frogs at times get into my ponds. In the blue heron and king-fisher, especially the former, the young carp find a great destroyer. All other enemies I can manage.

FOOD.—In addition to corn, oats, refuse of the slaughter-house, brewery, and kitchen, I give the carp small boiled potatoes.

GROWTH.—The old carp measure 22 inches in length; the young of this year that were in ponds not overstocked vary in length from 10 to 12 inches.

REPRODUCTION.—I number my young carp at 5,000. I cultivate the fish for sale, and have shipped them to all parts of the United States.

EDIBLE QUALITIES.—We have eaten carp both baked and fried. We relished them very much.

PRICE.—My price-list for 1883 has been as follows: German carp (scale, mirror, and leather), 25 for $3; 50 for $5; 75 for $7; 100 for $8; 10 per cent. off for 500 or more.

599. *Statement of John B. Browne, Nashville, Holmes Co., Ohio, Aug.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—The 13 carp received in November, 1880, and the 10 in the spring of 1883, I put in a pond ¼ acre in circumference, with a maximum depth of 7 feet, and a bottom composed of mud and gravel. In the summer of 1881, the flow of water was that of a ½ inch stream. In the summers of 1882 and 1883 an inch stream flowed through it.

PLANTS.—Cat-tail and calamus grow in the center, and oats and grass on the edges of the pond. The carp destroyed the water-cress.

ENEMIES.—We kill the frogs, turtles, and muskrats that infest the pond. No other fish inhabit it.

FOOD.—In addition to the 3 gallons of wheat-bran and corn-meal that I give the carp daily, they are fed whenever any one comes to see them.

GROWTH.—I have 2 of the original carp, which weigh from 5 to 6 pounds and measure 22 inches each. The others were stolen in the summer of 1882, in spawning time.

REPRODUCTION.—There are thousands of young in the pond, which are from 4 to 10 inches long.

SALES.—I have sold about 300 young.

DIFFICULTIES.—The only trouble is with thieves. I am building a guard-house and will shoot them.

600. *Statement of A. R. Liggett, Nashville, Holmes Co., Ohio, May* 8, 1882.

DISPOSITION OF CARP RECEIVED.—My carp were in splendid condition when I deposited them in my pond December 16, 1881. As I have seen no signs of them since, I have concluded that the water, which flows from a spring, is too cold for them. The quantity is sufficient to fill a 2½ inch pipe.

PLANTS.—It may be that the carp have secreted themselves among the moss which grows on the bottom of the pond to the height of 6 inches. There is also plenty of cress growing in the pond.

GROWTH.—Mr. John B. Brown informs me that 8 of the 13 carp deposited in his pond will average 16 inches in length. Mr. John Lee placed 15 carp in his pond November, 1881, and says that 6 of them are from 12 to 14 inches long.

601. *Statement of Joseph Messenger, Granville, Licking Co., Ohio, Aug.* 25, 1882.

GROWTH.—On December 1, 1880, I received a consignment of carp and placed them in a small hastily-constructed pond until the 21st instant, when I transferred the 2 remaining carp to another pond. These having made rapid growth, I am not displeased with the undertaking. One measured $10\frac{3}{4}$ inches and the other $12\frac{1}{4}$ inches. I have no young yet.

602. *Statement of Jennison Hall, Piqua, Miami Co., Ohio, Sept.* 12, 1882.

REPRODUCTION.—There is a party in this city that has 10,000 young leather carp to dispose of—produce of some sent here from Washington some 2 years ago.

603. *Statement of Charles Senseman, West Charleston, Miami Co., Ohio, Aug.* 9, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 scale and 10 leather carp received November 20, 1880, I put in a $\frac{1}{2}$ acre pond, with a depth of from 1 to 6 feet. It is fed by a strong vein of spring water, which is turned into the pond at various points whenever the water in it is cooler than the spring water. By this method the growing period is very much lengthened.

PLANTS.—Pond-lilies, wild rice, and water-cress grow in the pond.

ENEMIES.—A few catfish, frogs, and turtles inhabit the pond. I try to free the pond of vermin.

FOOD.—I give them shipstuff, boiled corn, and lettuce once a day. The small carp will come for food which they eat out of the hand, and are as gentle as kittens.

GROWTH.—An original carp that was injured and died in the summer of 1882 weighed $5\frac{1}{2}$ pounds. I found 18 of the original carp on drawing off the pond in June, 1882.

REPRODUCTION.—I estimate the number of young at hundreds or even thousands. They are from 4 to 8 inches long. The condition of the carp is excellent.

604. *Statement of Samuel Wampler, Dayton, Montgomery Co., Ohio, Aug.* 9, 1883.

DISPOSITION OF CARP RECEIVED.—I put 27 of the 31 carp received in March, 1881, in a pond covering $\frac{1}{4}$ acre, with a depth of from 6 inches to 5 feet, and a muddy and gravelly bottom. From 3 to 5 gallons of water at a temperature of 65° in summer, flow through this pond per minute.

ENEMIES.—Snapping-turtles, but no other fish than carp inhabit the pond. I do not feed the carp.

GROWTH.—I saw an original carp the other day which weighed from 3 to 4 pounds. I have been unable to catch any, though I seined my pond 3 times.

REPRODUCTION.—There are several hundred young in the pond, from 4 to 6 inches long, and some less than 1 inch in length. Some of the young weigh from 3 to 4 ounces.

605. *Statement of S. J. Stoner, Sulphur Grove, Montgomery Co., Ohio, Aug.* 6, 1882.

DISPOSITION OF CARP RECEIVED.—December 2, 1881, I received 21 carp in good condition, and placed them in my pond. I have since thrown in feed for them, but could never see any signs of the fish. Therefore, on the 1st day of this month I drew off the water, and, as I feared, found no fish. I have no idea what became of them.

606. *Statement of W. E. Logan, Andrews, Morrow Co., Ohio, Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 leather and 10 scale carp received on December 1, 1880, I put in a pond having a surface area of about 1,000 square yards, a depth varying from 6 inches to 4 feet, and a muddy bottom. As the spring does not furnish enough, I introduce water into the pond by means of a wheel. The temperature of the water at noon is 80 .

PLANTS.—A moss grows from the bottom, but does not reach the surface of the pond.

ENEMIES.—Sun-fish, frogs, and a few turtle are found in the pond. Sun-fish, especially, disturb the carp.

FOOD.—From two to three times a week I give the carp a considerable quantity of wheat-screenings. When I desire to get them to the surface, I give them light bread.

GROWTH.—In the fall of 1882, the original carp weighed from 3 to 5¾ pounds. The 3 pound fish were always small in comparison to the ones which weighed 5¾ pounds. There are 6 leather carp in the pond. I stocked other ponds near by with 13 of the original carp.

REPRODUCTION.—There were about 3,000 young from the first summer's spawn. They are now from 5 to 12 inches long. There also seems to be plenty of small ones of this summer's spawn from 2 to 5 inches long. A neighbor has young from my original lot. that are from 10 to 15 inches long.

DISPOSITION OF YOUNG.—I put about 300 young in Owl Creek, a tributary of Muskingum River. I also stocked 8 or 10 ponds with the fry.

DIFFICULTIES.—Before the wheel was erected the pond suffered for water. The carp with which I stocked other ponds ate their young.

MISCELLANEOUS.—Our little carp pond is a very interesting addition to the farm, as well as a pleasure to other parties, who come miles to see the carp feed.

607. *Statement of W. B. Lee, Waverly, Pike Co., Ohio, Oct.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—On April 1, 1883, you sent me 12 carp, Mr. Howell, of Toledo, gave me 9 more, and on the 25th of April I bought 40 that averaged from 4 to 6 inches in length. My pond covers 3 acres, has a deep black muck on the bottom, and contains most all kinds of aquatic plants, such as lilies, ferns, grasses, &c. Its depth varies from 1 to 7 feet.

GROWTH.—Some of the carp will now measure from 18 to 20 inches, and weigh from 4 to 5 pounds each.

608. *Statement of R. P. Cannon, Aurora, Portage Co., Ohio, July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The 12 carp received on November 5, 1880, I put in a pond, with a depth of 3 feet and a bottom of mud and gravel. All of them were destroyed during the following winter. The pond was covered with thick ice. I think they were injured by the shifting about and delay they received while in Cleveland, Ohio.

609. *Statement of William Moore, Camden, Preble Co., Ohio, July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received on November 19, 1880, I put in an 80-rod pond, with a maximum depth of 7 feet, and a muddy bottom. The pond is supplied with creek water. The temperature of the pond to-day is 82°.

PLANTS.—Weeds, moss, wild rice, water-plantain, and a slim trailing vine grow in the pond.

ENEMIES.—Bull-frogs and hard and soft shelled turtles are found in the pond. I try to destroy the turtles by shooting them.

FOOD.—I give the carp wheat-bread, and sometimes make corn-meal mush and soak pop-corn for them. I generally feed them daily.

GROWTH.—I have 2 of the original carp remaining, which average 20 inches in length, and weigh from 4 to 5 pounds.

REPRODUCTION.—There are at least 100 of the first year's spawning from 4 to 8 inches and a thousand from ½ to 1 inch long in the pond. They spawned in 1881.

DIFFICULTIES.—The high water in June, 1882 allowed all the original carp but 2 to escape.

610. *Statement of John Francis, Gillespieville, Ross Co., Ohio, Oct.* 24, 1882.

GROWTH.—On December 8 I received 20 carp, weighing from 2 to 3 ounces each, and put them in a pond prepared for their reception. I seined out 8 or 10 of them on the 13th instant, it being about 10 months since I received them, and found some of the largest ones to be about 16 inches long and to weigh 4 pounds. They are all alive and doing well.

611. *Statement of Lewis Leppelman, Fremont, Sandusky Co., Ohio, July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 carp received on November 4, 1879, I put in a small pond, with a depth of 4 feet and a muddy bottom. A 1-inch stream supplies it with water.

PLANTS.—Flags, water-lilies, and other grasses grow in the pond.

ENEMIES.—Nothing that destroys the carp inhabits the pond.

FOOD.—Three or more times a week I give the carp potatoes, corn, liver, and refuse from the table. They are ever ready for food, and seem to relish everything that is given them.

GROWTH.—The original carp are from 15 to 18 inches long. I think I have all of them. On account of grass and mud I cannot see whether there any young yet.

612. *Statement of J. L. Stanley, Freeburg, Stark Co., Ohio, Apr.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in the latter part of the year 1882, and a lot on the fourth day of the following April. I broke the ice when I placed the first lot in the pond. Only 1 of the second lot was dead on receipt, and the remainder I placed also in the pond. The water which supplies the pond is clear most of the time, and the stream is no larger that ¼ of an inch; yet it keeps both of my small ponds full.

FOOD.—I give the carp bread and boiled rice.

DIFFICULTIES.—I was very unfortunate with my first lot of carp on account of a defect in my dam, and the second lot have also subsequently died. I cannot account for this as the sun-fish and suckers, which I put into the pond after the death of the carp, seem to do well. Tadpoles flourish in the pond, and there is a slight sulphur appearance near the spring.

613. *Statement of D. M. Slusser, Louisville, Stark Co., Ohio, Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—The carp received in December, 1882, I put into a pond 40 by 300 feet, with a depth of from 10 inches to 4 feet, and a bottom of muck and gravel. Springs at the bottom of the pond supply it with water during the entire year. It has no outlet.

PLANTS.—I remove the moss that grows from the bottom of the pond several times each season.

ENEMIES.—Red, or gold fish, sun-fish, frogs, and turtles are found in the pond. I am trying to seine out all but the carp.

FOOD.—I do not feed the carp.

GROWTH.—A carp caught to-day was 24 ounces by actual weight, which indicates that they have wonderful growing qualities. I shall cultivate carp in preference to any other fish. They are likely to give entire satisfaction wherever introduced. My carp have not spawned yet.

DIFFICULTIES.—The first lot of carp received in the winter of 1880–'81 was frozen during the severe winter.

614. *Statement of James Bayliss, Massillon, Stark Co., Ohio, July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I have 3 ponds that were formed by constructing as many dams across a small ravine. The first pond is 20 by 20 feet, and is 2½ feet above the second dam, which forms a pond 20 by 90 feet. The third and lowest pond is 2½ or 3 feet below the second dam, and is 100 by 150 feet. Into this third pond I placed the 15 carp received on November 11, 1880. An average stream of from 2½ to 3 inches of clear, cool water that rushes from a limestone rock in a hill adjacent empties into the first pond. The other ponds receive their supply of water from the first pond. The temperature of the first pond is 55°; second, 60°; and the third, 65°. They are from 3 to 4 inches deep, and have very muddy bottoms.

PLANTS.—A few plants and 1 kind of pond-lily grow in the pond. Sometime a green scum which grows from the bottom accumulates on the surface.

ENEMIES.—Craw-fish, frogs, muskrats, and tadpoles inhabit the pond.

FOOD.—I do not feed the carp.

GROWTH.—Last May 2 of the original carp weighed, respectively, 5 and 7 pounds, and the larger one measured 22 inches.

REPRODUCTION.—There are from 300 to 400 young in the pond, and they measure all the way up to 8 inches in length.

DIFFICULTIES.—A few months after the completion of the ponds, a sudden rise of water washed out a small place in the breast of the dam and allowed some of the carp to escape. These were floundering about in puddles in the meadow below. I replaced 3 or 4, which were all I could find, hoping they would live and do well, but they always kept hid or were in the mud. It was only until the following May, when the pond was very low, that any fish were discovered.

The following day after the 2 original carp were caught, I found that the 2½-inch holes that had been bored in two pump-logs under the dam to enable me to draw off the water at pleasure had been tampered with, and both were wide open. All the water and many fish were allowed to escape. I put the the pond in repair immediately, as my pond is adapted to carp culture. I hope to make it a success.

615. *Statement of David Fosdick, Cuyahoga Falls, Summit Co., Ohio, Aug.* 9, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1880, I received 15 carp. My artificial pond is 7 by 50 feet, from 2½ to 3 feet deep, and has a bottom composed of clay, sand, and gravel. Ten gallons of spring water flow into the pond per hour. In summer the temperature is from 70° to 74°, and when it empties in the pond it is 60°.

PLANTS.—Clover and timothy grow on the banks of the pond.

ENEMIES.—A few frogs only inhabit the pond.

FOOD.—I give the carp bread-crumbs and mashed potatoes daily.

GROWTH.—Each of the 7 original carp remaining weigh about 2½ pounds.

REPRODUCTION.—There are about 500 young in the pond, and they are from 2 to 6 inches long.

MISCELLANEOUS.—It is my intention to make arrangements for a more extensive culture of the carp, and if I find them to be a good food-fish I shall still further increase the number of ponds. Meat is getting high and scarce. People will have to come down to fish. I do not think the supply will equal the demand, although to give the carp the chance they will increase very fast.

616. *Statement of R. H. Lodge, Cuyahoga Falls, Summit Co., Ohio, July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I put the 16 scale carp received in October, 1880, and 17 leather received in the fall of 1882, into an artificial pond, with 27 rods of surface, a maximum depth of 4 feet, and a bottom of clay, sand, and muck. During the warm weather, enough water flows into the pond to maintain a uniform depth. In spring and fall the surplus water passes through a 2-inch pipe. In summer the temperature of the water as it reaches the pond is from 60° to 62°.

PLANTS.—Water-lillies and various kinds of plant and grass grow in the pond.

ENEMIES.—A few turtles and frogs inhabit the ponds. It contains no other fish than carp.

FOOD.—I feed the carp on chopped cabbage, lettuce, and boiled rice. But bread-crumbs and refuse from the picnic tables, which I give them daily in summer, they seem to devour more eagerly.

GROWTH.—The 4 carp remaining will average from 18 to 20 inches long, and weigh probably 4 pounds net. In May, 1883, I had 8 leather carp which were each 1 foot long.

REPRODUCTION.—In the spring of 1883 there were about 2,000 young in the pond. Some of the yearlings are 10 inches long. I do not see any of the young of the leather carp.

DISPOSITION OF YOUNG.—I sold most of the young at $7 per hundred. When the others are large enough to care for themselves I intend to put them in Silver Lake—a body of water which covers 105 acres.

DIFFICULTIES.—In the spring of 1883 I lost 15 original carp by removing them to a fountain bowl newly plastered with Portland cement.

617. *Statement of S. P. McFall, Newton Falls, Trumbull Co., Ohio, July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 scale carp received about December 1, 1880, and the 20 mirror, received in 1881, I put in 2 ponds, each covering about ¼ acre and having muddy bottoms. Both ponds are fed by a very small supply of warm spring water.

PLANTS.—White and yellow pond-lily, water-plantain, arrow-head, and wild grass grow in the pond.

ENEMIES.—Carp alone inhabit the pond.

FOOD.—I give the carp wheat-screenings and refuse from the kitchen daily at sunset.

GROWTH.—In the fall of 1882 the original carp averaged 8½ pounds. I have one mirror carp remaining.

REPRODUCTION.—The young of the scale carp number 700, and are from 1 to 6 inches long.

SALES.—I sold 100 young.

DIFFICULTIES.—About February 1, 1883, all of the mirror, except 1, turned yellow and began dying about February 20. The scale carp were not quite so yellow, but also died about the same time. Only 25 small scale carp and the 1 mirror carp escaped.

618. *Statement of B. G. Schenck, Franklin, Warren Co., Ohio, Sept.* 15, 1883.

DISPOSITION OF CARP RECEIVED.—The 24 carp received about the middle of December, 1882, I put in a pond 54 by 150 feet, with a depth over the upper two-thirds of about

3 feet, gradually increasing in the lower third to about 5 feet at the lower end, where a 5-inch drainage pipe, capable of draining the pond in 7 hours, has been placed. The bottom is an admixture of yellowish-black clay. That it and other conditions are favorable to the development of the carp can perhaps be best judged from the condition of the fish at this time, feeding having been adopted but a short time, and no growth of aquatic plants having been as yet secured. It is fed from a never-failing limestone spring, at a uniform temperature of 58°, and which issues from the ground at a distance of 170 feet from the pond.

PLANTS.—Attempts were made to secure a growth of pond-lilies, but without success, and means will be provided to establish, if possible, a good growth of the common water-grasses of this region.

ENEMIES.—At the bottom of the pond 3 snapping-turtles of an average length of 7 inches were found and summarily dispatched.

FOOD.—I did not feed the carp until about September 1, when small quantities of food, such as wheat, oats, &c., from time to time were given them; and, later, green corn cut from the cob was thrown into the pond near the edge, all of which was eaten with avidity.

GROWTH.—On September 12 the water was drawn off, and 14 fish were found to have survived. All of them were scale carp except 3, which had a ½-inch stripe on either side, running from the head to the tail, and being devoid of scales. These 3 fish were among the largest of the lot. The actual aggregate weight of the 14 carp was 20¾ pounds, varying from 1 pound to 2¼ pounds. This growth has taken place in a pond where there is apparently little or no food. As soon as a proper condition of the pond, as regards the food supply, can be secured, and a more regular and constant feeding adopted, it is believed that even a greater size will be attained.

PONDS TO BE CONSTRUCTED.—I intend to build 2 other ponds, a hatching pond and a carp pond proper. The pond in which my fish are now kept will become the breeding one, to the east of which will soon be constructed the hatching-pond, 30 by 65 feet, and from 6 inches to 2 feet in depth. Below these 2 will be built the carp pond proper, 90 by 275 feet, with a depth of from 1 to 3 feet, and increased from 1 to 6 feet in the ditches and kettles, or collectors, and provided with a proper drainage pipe. The water from the hatching pond is taken from the breeding pond after the temperature has been increased by the sun. From the hatching pond it passes into the carp pond proper.

619.—*Statement of John Hoff, Mason, Warren Co., Ohio, Jan.* 18, 1884.

GROWTH OF CARP.—I paid a visit to the Union village, in our county, in August, to see the carp pond there, and learn something in regard to the care of these fish. I found that they had three sizes in it; the ones they received from you two years ago last November, those that were one year old, and the little ones that had hatched in June and July. The latter were from 1½ to 2 inches long. The clever Elder presented me with 5 yearlings that were from 12 to 16 inches long.

PURCHASE OF CARP.—Last fall I purchased, additionally, from Mr. H. W. C. Muth, of Mount Healthy, Ohio, 105 carp for $8. These were from 5 to 7 inches in length, and were placed in my large pond, located about 50 yards from the house. It is so well located that it has not been frozen completely over this winter, although the thermometer has marked 20° below zero several times. I shall prepare a breeding pond for the yearlings.

620. *Statement of Matthew B. Carter, Shaker, Warren Co., Ohio, Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received in the fall of 1880 I put in a 1-acre artificial pond, having a bottom of dirt or clay. It is fed by water which runs through a 2-inch pipe, and is warm in summer. It freezes in winter.

PLANTS.—Wild grasses and some weeds grow in the pond.

ENEMIES.—Frogs and a few turtles alone inhabit the pond.

FOOD.—I occasionally give the carp refuse from the kitchen, and grain. I seldom feed them.

GROWTH.—Each of the original carp remaining weighs 5 pounds.

REPRODUCTION.—There are fully 10,000 young in the pond, and they weigh all the way up to 1½ pounds.

MISCELLANEOUS.—Carp can be grown here at less cost per pound than beef, pork, or mutton.

621. *Statement of Samuel Baughman, Springborough, Warren Co., Ohio, Sept.* 21, 1883.

DISPOSITION OF CARP RECEIVED.—About the middle of December, 1881, I received 13 carp, and to them added 14 more received from my neighbors, who also obtained

them of the Fish Commission. I put the fry in one of the two ponds which are already completed. They are each 100 by 175 feet, with respective depths of from 1 to 12, and 1 to 8 feet, and bottoms of loam and clay, the combination of which is evidently favorable to the propagation of the carp. The inner edges of both are walled for a space with stone, as is also the outer wall of the deeper of the two. They are side by side, separated by a narrow embankment, and well protected from any considerable inflow of surface water. Several springs and water flowing from the drains, of a limestone character, feed the ponds. Below these will be completed the hatching ponds, 30 by 200 feet, and from 6 inches to 3 feet in depth. The carp pond proper, the area of which will be about 2½ acres, and the depth all the way up to 20 feet, will be formed by the construction of an embankment about 25 feet in height, with a base of not less than 40 feet. All of these ponds will be provided with proper drainage pipes, screens, collectors, &c.

ENEMIES.—There have been no other fish in the pond since its construction.

FOOD.—The carp have been fed with small grain quite regularly. Hereafter they will be fed as regularly as the stock on my place.

GROWTH.—The old carp are now 18 or more inches in length, and weigh from 3 to 4 or more pounds each. They are healthy in appearance and have grown rapidly, but, as the result of the food I intend to give them in the future, I expect that the growth will be even greater than it has thus far been.

REPRODUCTION.—Little attention was paid to the carp until the following summer after they were received, when it was discovered that the pond contained large numbers of young fry (1882). They are now from 12 to 15 inches in length, and weigh from 1 pound to 2 or more pounds each. The carp spawned again this summer, and the large numbers of fry average from 4 to 5 inches in length.

MISCELLANEOUS.—In addition to the 2 ponds that I have completed and the one now in course of construction, I intend to build a small one to be used for experimental purposes. A number of carp will be selected, carefully weighed, regularly fed, and the quantity of food noted. At the end of the season the carp will be weighed again to determine the increase in weight, thereby ascertaining the income to be derived from the capital invested. Hundreds of young as large as the hand were seen in the pond November, 1882.

622. *Statement of W. H. Carpenter, Springborough, Warren Co., Ohio, Sept.* 9, 1882.

DISPOSITION OF CARP RECEIVED.—The carp received on December 31, 1881, were placed immediately in a pond, circular in shape and 80 feet in diameter. The water is supplied from a spring and is from 1 foot to 4 feet deep. The bottom is composed of yellow sand and black mud. It is situated on a high piece of land with a gentle slope to the south.

PLANTS.—Grass and cress grow around the edges of the pond.

FOOD.—In March we saw two or three of the carp and fed them occasionally, but discontinued because they disappeared.

GROWTH.—One of the dead carp was 15 inches long and the other two about 14 inches each. The 3 together weighed 7¼ pounds. In 2 days after the dead carp were found we saw 3 more about the same size.

MORTALITY.—On August 29, 1882, I found 3 dead carp that had floated to the edge. Two of them looked as if they might be alive, being without a mark, and the other looked as if it had been dead longer and was somewhat eaten, one fin being gone and the mouth being somewhat torn.

623. *Statement of Frank Knowles, Little Hocking, Washington Co., Ohio, Oct.* 15, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in the fall of 1881.

FOOD.—They come to their regular feeding place every evening for their daily bread.

GROWTH.—May 1, 1882, the largest were 6 inches long. Some of them now measure 20 inches and will weigh from 3 to 3½ pounds each.

MISCELLANEOUS.—I exhibited a pair of them at our county fair, where they attracted much attention. They failed to spawn this season. I have changed them into another pond with plenty of water, hoping that they will spawn there.

624. *Statement of John Hall, Marietta, Washington Co., Ohio, July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I put the 12 carp received on December 15, 1880, in a pond under the assurance of the owner that there was always a sufficient supply of water. It, however, soon dried up, and I lost them.

625. *Statement of John Lee, Big Prairie, Wayne Co., Ohio, Mar.* 21, 1884.

DISPOSITION OF CARP RECEIVED.—The 15 scale carp received on November 15, 1880, I put in a pond covering ¼-acre, with a depth varying from 1 to 5 feet, and a mucky bottom. A 3-inch tile-drain conducts the surplus water from the pond. Its temperature is 60°.

ENEMIES AND FOOD.—Frogs and turtles, but no other fish than carp inhabit the pond. Almost daily I give the carp bread.

GROWTH AND REPRODUCTION.—The 6 old carp remaining average about 18 inches in length. There are many young in the pond, and they are about 3 inches long.

DISPOSITION OF YOUNG.—I have given away 100 fry.

626. *Statement of J. H. Rumbaugh, Deunquat, Wyandot Co., Ohio, Dec.* 12, 1883.

DISPOSITION OF CARP RECEIVED.—About the 10th of May, 1881, I received 26 carp. I received some since, but lost them. My pond is 25 by 50 feet, with a dept of from 1½ to 3 feet. The bottom is mucky. The pond is supplied with water from a spring rising up in one corner of it. Generally the water overflows, except in hot, dry weather, when it evaporates as rapidly as it comes into the pond.

PLANTS.—The pond contains white and yellow water-lilies. The banks of the pond are covered with red-top grass and white clover.

ENEMIES.—With the exception of some black bass that got into the pond during high water in June, 1882, the pond contains nothing but frogs.

FOOD.—I give the carp dry bread, sweet green corn (which I cut off of the cob), and thick, sour milk. The milk is fed to them by pouring it into a trough placed 6 inches below the surface of the water. The small carp will eat out of the trough like pigs. I have not fed to them a quantity sufficient to keep one hen alive. I have seen carp jump a foot or more out of the water after a sprig of red-top grass, and strip seed off of it.

GROWTH.—One of the original carp on the 7th of October weighed 7 pounds, 10 ounces. There are but 4 of them left.

REPRODUCTION.—About 200 young carp were produced the first season (1881). None were produced the second season (1882). In another pond I put 9 old and 40 young carp, which produced 300 young carp. Eighteen of the carp of 1882 on the 1st of October weighed 73 pounds. The 1883 fish measure about 2 inches in length. With the young carp I have stocked two other ponds, one larger and one smaller than the pond in which I cultivated them.

EDIBLE QUALITIES.—I have eaten carp fried. Unless it be the black bass, I pronounce the carp the best fish I ever ate. Those I ate were rather bony, but I suppose were I to eat a large one I could not raise that objection. The carp I ate averaged 1½ pounds in weight.

OREGON.

627. *Statement of M. C. George, M. C., Portland, Multnomah Co., Oreg., Oct.* 16, 1882.

GROWTH.—A few weeks ago I had for our dinner a carp which you sent in the spring to Captain Kerns. It weighed over 2 pounds, and many of them are much larger than that one.

628. *Statement of David A. Wilson, Tygh Valley, Wasco Co., Oreg., Oct.* 2, 1882.

GROWTH AND REPRODUCTION.—I put the two pairs of carp, 7 inches long, received last fall into a pond about 100 feet square and 3 feet deep; here they have increased in size until they measure 15 inches in length and weigh 3 pounds each. They have raised several hundred young, those first hatched being about 6 inches long.

PENNSYLVANIA.

629. *Statement of C. E. Goldsborough, Hunterstown, Adams Co., Pa., Sept.* 1, 1884.

GROWTH.—Of the 18 carp received on April 18, 1882, but one survived, owing to the pond not being ready. Last spring this one carp was found to have grown from 8 inches to the length of over 2 feet.

DIFFICULTIES.—I received another supply of carp on November 18, 1882, but up to June 26, 1884, when an unprecedented flood allowed my old carp and what other carp there were in the pond to escape into Connewago Creek, I saw nothing of them.

630. *Statement of Philip D. Weaver, Menallen, Adams Co., Pa., Aug.* 27, 1884.

GROWTH.—I received 7 carp not 2 inches long in November, 1881. These carp are now 2 feet long. In one pond I have 1,000 young about 14 inches in length and 5,000 but little less than 2 inches long, and an unlimited number of smaller fry. The old ones are 2 feet long now.

631. *Statement of C. C. Lobingier, Braddock, Allegheny Co., Pa., Aug.* 9, 1883.

DISPOSITION OF CARP RECEIVED.—The 16 scale carp received on November 3, 1880, I put in a pond 25 by 60 feet, with a depth varying from 15 inches to 4 feet, and a bottom of clay. A 1½-inch stream of cold spring water supplies the pond.

PLANTS.—Common grapes grow around the pond and out in the water. I put pond-moss and water-cress in the pond repeatedly, but the carp devour them as fast as I put them in.

ENEMIES.—No other kinds of fish, but plenty of water-snakes, bull-frogs, and crabs inhabit the pond.

FOOD.—I give the carp bread and vegetables 3 or 4 times a week. They seem to prefer fish-worms and watermelons to anything else.

GROWTH.—There are 14 carp remaining. One jumped out of the pond and died. They are from 12 to 18 inches long, and weigh 2 or 3 pounds.

REPRODUCTION.—There are more than 100 young in the pond this year, which are from ½ to 2 inches long. I discovered no fry until June, 1883.

DIFFICULTIES.—The water that empties into my pond is too cold for the carp. I think if the water had been warmer my carp would be much larger. The greatest drawback I have to contend with is the numerous snakes and crabs that inhabit my pond.

632. *Statement of J. W. Higbee, Castle Shannon, Allegheny Co., Pa., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 scale carp received on November 10, 1880, I placed in 2 ponds covering, respectively, ¼ and ¾ acre, having maximum depths of 6 and 8 feet, and muddy bottoms. A 3-inch stream of water at a temperature of 70° flows through the ponds. The average depth is 2 feet. The ponds are constructed so that I can draw off the water.

PLANTS.—Water-lilies and willows grow in the pond.

ENEMIES.—Minnows and bull-frogs inhabit the larger pond. Nothing that disturbs the carp inhabits the smaller pond, which I use as a spawning-pond.

FOOD.—I give the carp stale bread daily, and occasionally give them corn and wheat.

GROWTH.—The 12 carp remaining average about 24 inches in length and weigh about 8 pounds. One measured 22 inches last April. Three of the old carp have scales 1½ inches in diameter.

REPRODUCTION.—There were 292 young hatched last year and thousands this year. The yearlings average 12 inches in length and 1 pound in weight. The fry are from 1 to 4 inches long. I moved the young last spring to the large pond. There is a great difference in the size of the fish of the same age.

DIFFICULTIES.—I have had trouble in killing the muskrats.

MISCELLANEOUS.—If the carp continue to do well I will build another pond. I keep only 9 of the old carp in the breeding pond, and shall keep no more than 6 there next year.

633. *Statement of George Finley, East End, Pittsburgh, Allegheny Co., Pa., Jan.* 5, 1880.

DISPOSITION OF CARP RECEIVED.—I have my carp in what I call my fountain pond, a circular basin about 24 feet in diameter with a center of stone work with a hollow center into which the fish can go. This basin is paved with brick in the bottom and has a girdle of 5 or 6 feet of boulders along or around the upper edge. It resembles in form an immense wash basin, and in the bottom of it I have a draining arrangement just like a wash-basin in a bath-room. The stone work in the center is surmounted by a patent revolving and pulsating fountain.

The water in this basin is about 3 feet deep, but before placing my fish in it I put a large number of large boulder stones in the deepest part and over them I threw a large amount of a fern that grows in the bottom of my breeding ponds, and also a lot of old dead leaves from the maples alongside the basin. Over the boulders and litter I laid large, flat stones, under which the fish can take shelter; and over these stones I stretched plank and weighted them down with stones. I then raised the water and put in the fish as soon as I got them.

The winter here is so far an unusually open one, with the exception of a few days, when

the ice was frozen to the thickness of from 2½ or 3 inches on shallow ponds. This is all gone, and for some time past the ponds have been, and are now, free from ice.

DIFFICULTIES.—I have found several of my smallest carp dead and also one of the large ones. I have not lost over 8 or 9. To-day, and for a few days past, I observed the smaller ones swimming near the top of the water with something of a wiggling motion, but they take alarm and shoot down when I approach them. I am sorry to see them acting thus, as I feel certain it is not a healthy sign and bodes a loss of more of them. The large ones which I got in the first lot show themselves much the stronger fish, as I have found but one of them dead and one sick. The latter, which I put in a reservoir in the spring-house cellar, has gotten well. The fish I found dead did not show any outward signs of having been injured, and I am quite at a loss to account for their dying.

My new pond is now full of water and is an entire success, not leaking a drop. I made it in exact accordance with views acquired by actual experience of over 20 years.

634. *Statement of George Finley, East End, Pittsburgh, Allegheny Co., Pa., Jan.* 10, 1880.

DISPOSITION OF CARP RECEIVED.—I put 10 of my largest carp in a separate pond with a bottom very soft and muddy, and I have not seen any dead ones in it as yet. It had a deep hole in the bottom about the size of a wash tub, over which I stretched a plank so as to come down and close it. I had 50 in the first lot and 117 in the second, so with my losses I still have about 140 fish. I do not think the cold weather has caused the deaths, but as it is very common to find large numbers of dead goldfish floating in the winter and spring, the death-rate may be nothing unusual, they being of the same nature as carp. The bottom of the pond has a large amount of litter, such as leaves and dead grass and muck, so I cannot think the fish suffer for want of cover, and I am hopeful of carrying most of them over the winter safely.

DIFFICULTIES.—One of the largest ones had a wound from which I think it died. I find that moving the sick ones to other water does not do very much good; they die as a general and almost universal rule. I cannot say I am discouraged about some of my carp dying, as the number so far does not amount to more than from 18 to 25, and only 3 of them large ones. As they all float when dead, I presume I know the number pretty certain.

635. *Statement of George Finley, East End, Pittsburgh, Allegheny Co., Pa., Apr.* 18, 1880.

DESCRIPTION OF POND.—My fountain pond is paved, and hence no muskrat can find a lodgment there. In the center is a kind of round tower of rustic masonry and an opening inside about 3 feet in diameter, covered with a large stone, and up through the center of this goes the supply pipe which drives the revolving fountain. On the side of this is a manhole, or place for a man to put his head in, in case of need of repairs—here the carp took up their winter quarters at the base of the pipe. Inside this home is a small opening to drop the water when the fountain is stopped, and out of which spouts a small stream when the fountain is in action. The place is dark and cosy, below the general level of the pond bottom, and suitable for a winter home for carp. Had I possessed a grating of iron the proper size, just too small for a muskrat to pass through, and abundantly large enough for the fish, I feel certain I would not have lost a single fish.

GROWTH.—I found only 9 live, healthy fish out of the two lots you so kindly sent me, and what astonished me most was that they have grown since putting them in. I measured one, and found it full 7½ inches long. They are in splendid condition. They hid in the mud in the most approved manner.

ENEMIES.—The muskrats have almost decimated my carp pond. There is another pond close by that has quite a number of muskrat burrows, and in which we have succeeded in digging out and killing several of the pests. The mild winter favored the raiders, but I have devised a permanent trap for them, and hope to make them scarce in the future.

636. *Statement of George Finley, East End, Pittsburgh, Allegheny Co., Pa., Sept.* 10, 1880.

DISPOSITION OF CARP RECEIVED.—Last fall I fortunately put 10 carp into a small pond much isolated from the others, situated at a spring in my orchard, and in the bottom of it I sank a bottomless box from 1 foot to 15 inches deep, the top being about on a level with the bottom. Over this I laid a long plank and weighed it down, leaving ample space to allow the fish to go into the box. This pond's bottom was of very deep black muck or greasy mud, in which these 10 fish wintered in safety. The other 8, the only ones that escaped the muskrats, have also a history. In my large new pond there

was a small amount of shallow and rather muddy water and much exposed to the sun's rays.

PLANTS.—I have 2 or 3 kinds of grass that grows very profusely in the bottom of one of my older ponds, and will plant it in the pond where I have my young fish. There is also a kind of saw-grass growing profusely along the edges of some of my small ponds. This I propose taking up in large sods and placing in the shallow water. I have a bridge or covering under which the fish can quietly lay in darkness during the winter season. The valve and draining-pipe are at the lower end and bottom of this ditch; and around the valve is a boxing, with spaces between the slats of ½ inch, opening at side and top, and up through which extends a bail to raise the valve by means of a hook. This is a most perfect mode of preventing the loss of fish by suction when lowering the water. I feel certain of 18 healthy fish at present and hope to winter them safely.

GROWTH.—On draining the water from this pond on the 21st day of August, 1880, I found a large fish and captured it with a dip-net, and to my astonishment it was one of my carp, which by actual measurement was 13 inches long. There being an outlet or connection between this pond and the fountain pond, it was not hard to account for its being there. I put it in the fountain pond with the other 7 until I got sufficient water in the large pond. I then drained the fountain pond and found that the other 7 fish were much smaller but very perfect and healthy. The fountain pond was of a much lower temperature and deeper than the other one in which the large fish grew. I infer from this that temperature has much to do with the growth of the carp. These 7 fish are now in this new, large pen, in the bottom of which I have a large ditch cut in the shallow bottom.

637. *Statement of George Finley, East End, Pittsburgh, Allegheny Co., Pa., Nov.* 4, 1880.

GROWTH.—On October 29, 1879, one of my carp measured 4½ inches in length. This same carp died on October 4, 1880, and was found to be 16½ inches long.

638. *Statement of George Finley, East End, Pittsburgh, Allegheny Co., Pa., Dec.* 7, 1833.

DISPOSITION OF CARP RECEIVED.—In October, 1878, I received 25 carp about as broad as my thumb and only a few inches long. I put them in 2 small ponds with different exposures and different temperatures in summer. I have also an artificial lake covering from 3 to 3½ acres, 2 other fine ponds, and close ponds.

CONSTRUCTION OF PONDS.—I have had 28 years' experience in fish culture, and as the carp is a still-water fish I think it only necessary to have enough water to keep the pond full. It is not necessary to have large ponds.

FOOD.—I feed the carp largely on stale baker's-bread. And while curd of milk and spoiled cheese are excellent for them, they will eat almost anything that a pig will eat.

GROWTH AND REPRODUCTION.—The following fall after I placed the carp in the pond I found that they averaged 16½ inches in length, and in the fall of 1881 were 19½ inches long and weighed 5 pounds. I have grown carp 9 inches in length from spring to fall, and a 6-inch carp in the spring grew to the length of 16 inches the following fall. I have also 18 months' old carp that are 18 inches long. This rapid growth only occurs when the parent fish are large and spawn early in spring. As you go farther south, where the summers are longer, even a greater size is attained. Last spring a large number of young were seined out of, but thousands of fine large fish, and hundreds of from 12 to 18 inches, were left in the lake. Carp are wonderfully prolific, and, in my opinion, nothing multiplies and grows faster.

EDIBLE QUALITIES.—Carp are palatable, nutritious, and healthy. Its flesh is of excellent flavor, and, like the shad, combines the qualities that go to make a perfect whole.

SUPERIORITY AS A FOOD-FISH.—The German carp being omnivorous is the only variety that can be profitably cultivated as a food-fish. I have given other varieties of food-fish, such as black bass, a long and fair trial, and the experiment ended in disappointment and pecuniary loss. No fish that requires live food alone can be profitably raised as an article of food.

HABITS.—Although they prefer to eat off the bottom, they come to the surface for their food, which they eat as regularly as ducks or chickens. The bread floats on the surface, and is torn and jerked under with the voracity of young sharks. They are like domestic animals to me.

HARDIHOOD.—Although the 12 carp, 6 inches long, which I sent to Florida in a large tin can were 5 days on their journey, they arrived in excellent condition. They stand transportation and rough usage wonderfully well, and, on being kept out of the water a reasonable time, do not die.

MISCELLANEOUS.—Carp, like other fish, take the hook of the angler more readily at some seasons than at others. Sometimes they cannot be induced to touch one.

639. *Statement of Robt. B. Phillips, Squirrel Hill, Pittsburgh, Allegheny Co., Pa., Dec.* 7, 1883.

DISPOSITION OF CARP.—In June, 1882, I obtained from Mr. George Finley 10 small carp, none measuring more than $5\frac{1}{2}$ inches in length and some were even less than that. I placed them in an ice-pond from 40 to 50 feet wide by about 120 feet long, having a maximum depth of 4 feet.

GROWTH.—I did not see the carp again until August, 1883, 14 months after they were put in the pond, when I drew off the water from the pond. All were astonished to see 10 large carp, the largest measuring $17\frac{3}{4}$ inches in length and the others 15, 16, and 17 inches. These were not of the thin, slim kind, but fully $3\frac{1}{2}$ inches thick and flat on the back. The carp were scooped up with a bushel-basket and placed in a small pond for inspection.

MISCELLANEOUS.—I examined the bottom of the pond and found no shelter of any kind in the shape of logs, brush, or stones. They wintered on the naked bottom.

640. *Statement of Samuel Daubenspeck, Brady's Bend, Armstrong Co., Pa., July* 24, 1884.

GROWTH.—The carp received 3 years ago spawned this spring. The old carp are now 30 inches long and weigh 7 pounds each. November 10, 1882, these carp weighed 3 pounds apiece.

641. *Statement of James Somerville, Brady's Bend, Armstrong Co., Pa., Oct.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received on May 3, 1881, I placed in an 8-acre pond with an average depth of $2\frac{1}{2}$ feet and a loamy bottom. An inch stream supplies the pond with water at a temperature of 70° F. in summer.

PLANTS.—Rushes and other grasses grow in the pond.

ENEMIES.—A few frogs infest the pond.

FOOD.—I give the carp cracked corn, bread, &c.

GROWTH.—The 2 carp remaining are 22 inches in length and 5 pounds in weight. There are no young yet. Last April I bought 10 more, then 5 inches long but now measuring from 11 to 14 inches in length, and weighing on the average 30 ounces each.

DIFFICULTIES.—More than $\frac{1}{2}$ of the first lot of carp died one week after I received them.

642. *Statement of S. H. Fegely, Kutztown, Berks Co., Pa., Oct.* 6, 1884.

DISPOSITION OF CARP RECEIVED.—Last November I received some carp and put them in a pond prepared for them. A part subsequently escaped during overflows of the water, but 9 remained.

GROWTH.—These 9 carp were weighed in the presence of many visitors who will verify the figures. The weights are as follows: 6 weighed 2 pounds; 2 weighed $2\frac{1}{2}$ pounds; and 1 weighed 3 pounds, making a total of 20 pounds for 9 fish, not over a year old. Two measured 14 inches in length; 4 measured 15 inches in length; and 3 measured 16 inches in length. They were 3 inches across the back and from 5 to 6 across the belly. All are scale carp except one, a mirror carp. A large number of persons saw the carp and all pronounced them very fine. I think this a wonderful result for these magnificent fish.

643. *Statement of John A. Biddle, Williamsburg, Blair Co., Pa., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received in July, 1880, I put in a pond near a creek. The temperature of the pond is 72°.

PLANTS.—Moss and water-cress grow in the pond.

DIFFICULTIES.—A heavy flood in May, 1881, broke my dam and allowed all my carp to escape.

644. *Statement of J. B. Miller, Canton, Bradford Co., Pa., Aug.* 15, 1883.

GROWTH AND REPRODUCTION.—I placed some carp in my pond about 3 years ago. On last Saturday, with a scoop-net, I brought up the first time 50 carp, measuring 6 inches in length. I think these were spawned last May. I brought up as many the next haul, and several were 18 inches long, spawned over a year ago. Some of the largest jumped out of the net. The one that was dressed for breakfast weighed $3\frac{1}{2}$ pounds, and its flesh was white and fine and almost free of bones.

645. *Statement of William Daubenspeck, Bruin, Butler Co., Pa., Feb.* 12, 1883.

GROWTH.—The 3 carp from 3 to 5 inches long received from Mr. Findly last May cost me \$2. I placed them in my pond a short time after I received them. I found, after draining

my pond the last of October, that the largest one measured 14½ inches and weighed 2¼ pounds, and the others measured respectively from 12 to 13 inches and weighed from 1 to 2 pounds.

646. *Statement of William Thompson, jr., Lemont, Centre Co., Pa., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—Of the 18 carp received on November 16, 1880, I placed 15 carp in a pond 50 by 100 feet, having a maximum depth of 3 feet. It has a muddy bottom, and is supplied by a 1½-inch stream of warm water. The other 3 carp died before the pond was completed.

PLANTS AND ENEMIES.—Nothing but moss grows in the pond. Frogs and tadpoles inhabit it.

FOOD.—I do not feed the carp.

GROWTH.—We have eaten 3 and suppose there are 12 carp remaining. One taken out July 23, 1883, weighed 3 pounds and 13 ounces and measured 20½ inches in length.

REPRODUCTION.—There are hundreds of young in the pond which are from 1 inch to 6 inches long, the longest weighing about ½ pound each.

DISTRIBUTION OF YOUNG.—I gave 40 of the fry to John J. Thomson, jr., Lemont, Pa., in November, 1882.

647. *Statement of W. R. Shelmire, Avondale, Chester Co., Pa., July* 21, 1883.

LOSS OF THE CARP RECEIVED.—In the spring of 1880 I received about 18 carp, all of which I lost by an accident to my pond.

648. *Statement of C. J. Morton, M. D., Toughkenamon, Chester Co., Pa., July* 11, 1881.

GROWTH.—I have reason to think that all of the carp received in the fall of 1880 are alive and doing well. They glide by me almost every day and appear to be as large as shad. I caught one about 2 weeks ago which measured 16 inches in length.

FOOD.—I feed them every morning and often in the evening on curd and mush, and beans and corn first boiled and then run through a sausage-cutter. I also often dig earth-worms for them.

649. *Statement of Samuel S. Conard, West Grove, Chester Co., Pa., Dec.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received on May 25, 1880, and the 19 received in December, 1882, by Mr. M. Conard were placed in a pond 40 by 60 feet, with an average depth of 1½ feet and a bottom of mud and gravel. A very small stream from a spring which rises from 200 to 300 yards distant supplies the pond.

PLANTS AND ENEMIES.—Rushes and water-lilies grow in the pond. A few frogs and small turtles get in, but no other fish than carp inhabit it.

FOOD.—I give them bread and sorghum occasionally.

GROWTH.—In 60 days the original carp grew from 3 inches to 7 or 8 inches in length. Those received in December, 1882, were about 2 inches long, and July 26, 1883, measured from 9 to 11 inches, and all doing well. September 1, 1883, the largest was 12½ inches long.

DIFFICULTIES.—By mistake, the supply of water was cut off from the pond in August, 1880, and the first lot of carp perished.

650. *Statement of Joseph Pyle, West Grove, Chester Co., Pa., Dec.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received in June, 1880, and 20 more received in November, 1882, I put in a pond covering about ⅓ of an acre, with a depth of from 1 to 3 feet, and a muddy bottom. In summer, 15 gallons of spring water flow through the pond per minute.

PLANTS.—Water-lilies, cat-tail, a quantity of grass similar to fox-tail, and a species of dock grow in the pond. They relish cat-tail very much.

ENEMIES.—Turtles, a few minnows, and small sun-fish, and a great many frogs inhabit the pond.

FOOD.—I did not feed the carp until August and September, 1882, when I gave them sweet corn in the milky state. When I desire to see them I sometimes give them bread and crackers.

GROWTH.—The 3 original carp average from 23 to 25 inches in length, and 8 pounds in weight.

REPRODUCTION.—There were more than 1,000 young in the pond last season (1882), and I judge there are from 5,000 to 10,000 this season. The yearlings vary in length

from 6 to 15 inches, but have not grown as rapidly as the original carp in the same length of time. This may be due to too many (600 to 700) in so small a space. The young hatched this summer are very fine, and are about two inches long.

SALES.—Last year I sold and gave away about 200, and have the balance in the pond. This season I have sold nearly $100 worth of carp at 10 cents each.

DIFFICULTIES.—One of the old carp flirted out of the water on the bank, and 6 others disappeared.

EDIBLE QUALITIES.—My table has frequently been supplied with fish of the finest quality. The flesh of the carp is very white, and of the finest flavor.

651. *Statement of P. Curley, Williams Grove, Clearfield Co., Pa., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—November 15, 1880, I received 13 carp, about 2 inches in length, and put them into a pond about 100 yards square, with a mud bottom covered with thick moss. It is fed by one of the best springs in the county, which is cold in summer and warm in winter.

PLANTS AND ENEMIES.—The water contains cresses and other wild grass, and also contains a good many lizards and some catfish.

FOOD.—I have fed the carp once a week with wheat-bread, corn meal baked, cold potatoes, and lights.

GROWTH.—The original carp are now 12 to 14 inches long. I would not sell one at any price.

REPRODUCTION.—About spawning time I could often see 6 at a time. They dart under the moss as soon as they see any one. I cannot tell whether they have any young.

652. *Statement of William Bahme, Newlin, Columbia Co., Pa.. July* 14, 1884.

DISPOSITION OF CARP RECEIVED.—I received 41 carp in December, 1880, and have received 20 since. One of my carp ponds has half an acre in it, and the other a third of an acre. The dam is 25 feet thick at the bottom, growing narrow at the top. The greatest depth of the pond is 6 feet, running out to nothing. Part of the bottom is composed of clay and part of gravel and mud. There are on the bottom some great stones, 9 feet long, which are raised up somewhat so that the fish can creep under them; grass has been planted on them, and the roots hang down. Water is supplied from springs, some nearly half a mile away, some a quarter of a mile away, and some in the middle of the pond. The water supply is regulated by a gate, and only so much comes in and so much goes out. During heavy rains we cut it off entirely, so as to prevent the lime and manure water from the fields from coming in. We can shut the gate from our bed-room window in case of night thunder storms. I never let more than 4 inches of water enter. Sometimes the water gets low, especially in winter. Then the minks catch the carp. While we have been at work on the pond the water has been very low, and I have kept two lanterns burning all night on the banks. Many people thought we could raise no carp because our water is cold.

PLANTS.—The plants are spatter-dock lilies, which I fetched from New Jersey; some of our lilies here, and many grasses, partly meadow-grass, through which the carp creep as natural as can be.

ENEMIES.—The cranes, minks, muskrats, snakes, and turtles have made me a great deal of trouble. I caught 87 muskrats in one year and 15 minks. We scraped the pond a few days ago, and it is clean now from all water animals. I found 5 eels. Five of my neighbors got carp, but their carp were all eaten up by snakes.

FOOD.—We feed the carp with boiled corn.

GROWTH.—November 6, 1883, there were 13 in all left, 8 or 9 being of the first lot and the rest of the second lot. They weighed 4 pounds, good weight. To look at them we thought they would weigh 7 or 8 pounds, but I put them in a bag and weighed nearly all of them myself, and 4 pounds was the most.

REPRODUCTION.—I saw young for the first time in my pond July 7, 1884.

EDIBLE QUALITIES.—I am 44 years old, and have fished ever since I was big enough to catch a whipping for fishing for red speckled trout, but never ate any such sweet and rich fish in all my time.

HOW TO CATCH CARP.—I caught some with a little minnow, since which time they are very shy.

653. *Statement of S. P. Graham, Linesville, Crawford Co., Pa., July* 21, 1884.

GROWTH.—Cold water killed all but 2 of the consignment of carp received by my father, George Graham, in 1881. These 2 carp now average about 5 pounds. They have not spawned yet.

654. *Statement of S. Weeks, Supt. W. Pa. Fish Hatchery, Corry, Erie Co., Pa., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—The 25 carp received in July, 1880, I put in a pond 35 by 100 feet, having a muddy bottom, and a depth of from 6 to 18 inches, except 10 by 25 feet in the center, where the water is 3 feet deep. The supply of water in summer, when it has a temperature of 75°, is equal in amount to that consumed by evaporation, and in winter is sufficient to prevent the pond from freezing over.

PLANTS AND ENEMIES.—Flags and water-lilies grow in the pond, and frogs and lizards inhabit it.

FOOD.—I did not feed the carp the first year, but I now give them cooked meal every other day.

GROWTH.—There were 9 carp in the pond last spring, which average 12 inches in length and weigh 1½ pounds.

REPRODUCTION.—The carp spawned for the first time last year, and when I netted the pond last fall only 150 young were found. The fish spawned again this year, but I cannot tell the number of young yet. The yearlings are 3 inches long.

MISCELLANEOUS.—We have given out 27 carp. The remainder we retain as yet. Carp are a very hardy fish and worth cultivating. None better can be grown here for the people. The carp would thrive better if the water in my pond was not so cold.

655. *Statement of J. W. Long, Mount Morris, Greene Co., Pa., Oct.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 mirror carp received June 1, 1880, and the 20 carp received November 15, 1881, I placed in 2 artificial ponds, one containing 2 acres and the other ½ acre. Each has a muddy bottom. A ½-inch stream of spring water and the drainage from a watershed of 30 acres feed the ponds.

PLANTS.—White water-lilies and bulrushes grow in the ponds.

ENEMIES.—Snapping-turtles, many small frogs, but no other fish than carp inhabit the ponds.

FOOD.—I do not feed the carp.

GROWTH.—I have all of the original carp but 1, which, having received an injury, died last fall. They averaged 10 pounds July 28, 1883. They attained a length of 15 inches within less than 5 months after their introduction into the pond.

REPRODUCTION.—My carp spawned when yearlings. I have a few young that are 2 years old which were 20 inches long July 28, 1883. The yearlings then averaged 1½ pounds. The ponds seemed to be full of young. My great success surpassed even my most sanguine expectations.

EXHIBITION OF CARP.—I placed my mirror carp on exhibition at the county fair and received $70 as a premium thereon.

DIFFICULTIES.—The only obstacle that confronts me is the destruction of the eggs by the carp themselves.

656. *Statement of E. B. Isett, Spruce Creek, Huntington Co., Pa., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1880, I received 2 lots of carp of 25 each, and 110 more in October, 1881. My 2 ponds cover, respectively, ¼ acre and 1 acre, and have muddy bottoms. The larger pond is supplied with water from the smaller, which is fed by the leakage from a mill race. The temperature of the water varies from 60° to 65°.

PLANTS AND ENEMIES.—Grass grows in the ponds. I try to rid them of the enemies of the carp, but still have a few snakes, frogs, turtles, muskrats, and other fish than carp to contend with.

FOOD.—As there is plenty of natural food in the ponds, the carp do not feed eagerly on the scalded chop that I give them.

GROWTH.—The original carp weigh from 3 to 5 pounds. Of the first 2 lots there are about 30, and of the last lot about 80 remaining.

REPRODUCTION.—There are many young about 2½ inches long in the ponds. They first spawned this summer.

DIFFICULTIES.—It is difficult to keep other fish, turtles, and snakes out of the ponds, and the muskrats from cutting the banks.

MISCELLANEOUS.—I expect to be well paid in a few years for the trouble I have had at carp culture.

657. *Statement of Henry Truman, of Jefferson County Sportsman's Association, Sigel, Jefferson Co., Pa., Aug.* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The 60 carp received by the Jefferson County Sportsman's Society in October, 1881, and another lot of from 25 to 30 received in the spring

of 1882, were placed in a pond especially constructed for carp, covering from ½ to ¾ acre. It has a depth of from 18 inches to 6 feet, a muddy bottom, and a supply of rather cold water from 3 good springs.

PLANTS.—Swamp-grass, skunk-cabbage, and a variety of plants grow in the pond.

ENEMIES.—Frogs and lizards inhabit the pond.

FOOD.—I gave the carp a variety of food at first, but have fed nothing for a year, supposing they were all dead, as I could see none of them.

GROWTH.—Two carp were washed out of the pond and were found in a small pool below in the spring of 1883. One of them weighed from 3 to 4 pounds and the other about 1¼ pounds. The carp were seen in the pond for the first time about 3 weeks ago, and from their actions I supposed they were spawning. There are the greater part of the original carp in the pond. They average about 15 inches in length.

658. *Statement of J. J. Carter, Lyles, Lancaster Co., Pa., July* 22, 1884.

GROWTH.—On the 10th of last May I put 60 carp in my pond. They were of last year's spawn, and ran from 1½ to 2½ inches in length. Just 71 days afterward, having occasion to draw off most of the water, I caught 4 leather carp. The largest measured 11 inches in length, the others from 1 to 2 inches less. This was not guessed or estimated length, but actual measurement with a rule.

659. *Statement of Benjamin L. Garber, Marietta, Lancaster Co., Pa., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received on June 8, 1880, I put in a pond 70 by 160 feet, with an average depth of 5 feet, and a bottom of clay and gravel. A 6-inch flow of limestone water from springs ½ mile distant supplies the pond.

PLANTS AND ENEMIES.—Several kinds of grasses and water plants grow in the pond. Turtles, green frogs, and various kinds of common fish inhabit it.

FOOD.—I never feed the carp.

GROWTH.—There are 7 carp remaining. I caught a carp in March, 1883, being about 3 years of age, that measured 21½ inches in length, 17½ inches in circumference, and weighed 5½ pounds.

I am at a loss to know why my carp do not increase.

660. *Statement of W. H. Aiken, New Castle, Lawrence Co., Pa., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 carp received in November, 1880, I put in a ¼-acre pond, with a depth of 3 feet, and a muddy bottom. A ½-inch stream of water, at a temperature of 70°, supplies the pond. The carp received subsequently I placed in public waters. This spring I removed the original carp to another pond.

PLANTS AND ENEMIES.—Water-lilies and wild rice grow in the pond. Frogs, but no turtles nor other kinds of fish, inhabit it.

FOOD.—Daily I give the carp bread.

GROWTH.—In the spring of 1883 there were 13 original carp remaining. They averaged 3 pounds in weight.

REPRODUCTION.—In 1882 there were several hundred young in the pond, but I cannot state the number. This year's increase is large. The young weigh from ¼ to ½ pound.

DISPOSITION OF YOUNG.—I placed the fry in public streams.

661. *Statement of Watson N. Dinsmore, New Castle, Lawrence Co., Pa., Nov.* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp from the United States Fish Commission in November, 1882. I had already bought from George Findley, of Pittsburgh, Pa., 7 goldfish, and from Henry Edenburn, West Middlesex, Pa., 27 carp. Last June a flood swept away the pond and carried all the fish except 1 goldfish into the Shenango and Big Beaver creeks. Since June I have built a levee between the rivulet and the pond 1 foot higher than the high-water mark, which I think will protect it hereafter. I have also bought from Mr. Edenburn 42 carp, and from Mr. Findlay 23 goldfish. These, with the 8 carp I have just received from the United States Fish Commission, I shall keep together this winter, but next spring I intend to separate the carp from the goldfish. No water can now get into the pond except spring water from below. The pond lies open to the sun and contains pond-lilies, dock, &c.

662. *Statement of Andrew Lewis, New Castle, Lawrence Co., Pa., Sept.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 carp received on November 6, 1880, and those received subsequently, I put in a pond covering 30 square feet, having a depth of

3 feet, and a muddy bottom. The pond is full of water a portion of the year, but it is stagnant in dry seasons. The temperature of the pond was 82° on a very warm day in August.

PLANTS AND ENEMIES.—The pond contains white pond-lilies and other water-plants, with roots extending and the leaves floating upon the surface of the water. Frogs inhabit it.

FOOD.—I gave the carp bread 3 times a week, but now feed them daily.

GROWTH.—I have no original carp, but the 4 carp of the second lot remaining average 12 inches in length and weigh 15 ounces. I have seen no young yet.

DIFFICULTIES.—The water got so shallow in the summer that the carp came to the surface.

663. *Statement of J. W. & E. Grove, Fredericksburg, Lebanon Co., Pa., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The 23 carp received in November, 1880, and the 20 received in December, 1881, we put in a pond 40 by 100 feet, with a depth of 5 feet, and a muddy bottom. We allow such an amount of spring water to flow into the pond as will equal that consumed by evaporation. The temperature of the water is from 60° to 65°.

PLANTS.—Water-cress and several species of potamogeton grow in the pond.

ENEMIES.—The pond is inclosed by a tight fence, and is not inhabited by anything that disturbs the carp.

FOOD.—I give the carp 1 quart of corn and 1 pint of wheat-screenings once a week.

GROWTH.—There are only 1 of the original and 6 of the second lot of carp remaining. They seem to grow rapidly. When we received them they were probably only 3 inches long, and in 12 months they measured 12 inches. The original carp is now about 20 inches long and weighs from 8 to 9 pounds. The other 6 average from 4 to 5 pounds. They have probably not spawned yet. I have seen no young yet.

DIFFICULTIES.—Before we enclosed the pond by a high tight board fence it was infested by muskrats and turtles. During the winter the former destroyed all of the original lot but one. In the spring, while drawing off the water from the pond, we found a large snapping-turtle, to which we attributed the destruction of the greater part of the second lot.

We desire more carp, as our pond is now in a good condition.

664. *Statement of Jacob G. Heilman, Jonestown, Lebanon Co., Pa., July* 27, 1883.

DESCRIPTION OF CARP RECEIVED.—The 9 carp received on June 3, 1880, I put in a mill-pond covering about 5 acres, with an average depth of about 5 feet and a bottom composed principally of mud. A large stream, at a temperature of 70° in summer, supplies the pond with water.

PLANTS.—The pond contains water-lily, dock, and a tall, rank grass that grows a seed.

ENEMIES.—Suckers, minnows, catfish, eels, and pike inhabit the pond.

FOOD.—I give the carp no artificial food, as I consider the supply of natural food sufficient.

GROWTH.—I have taken 3 of the original carp which measured, respectively, 24, 18, and 14 inches in length. The largest weighed $7\frac{1}{2}$ pounds.

REPRODUCTION.—I cannot estimate the number of young in the pond.

MISCELLANEOUS.—My dam is the last one on the Little Swatara, a prolific fish stream well adapted to the propagation of carp. I shall do all in my power to give the carp a permanent foothold, which, when gained, will result in the stocking of the entire stream, running a distance of about 15 miles.

665. *Statement of H. W. Jarrett, Emaus, Lehigh Co., Pa., Sept.* 29, 1883.

GROWTH.—The carp I received November 29, 1882, have done well. Yesterday I found 3 leather carp $12\frac{1}{2}$ inches long and weighing from $1\frac{1}{8}$ to $1\frac{1}{4}$ pounds each, beautiful in color and in shape.

666. *Statement of D. N. Kern, Shimerville, Lehigh Co., Pa., May* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received 9 scale carp in the spring of 1881, and 20 mirror carp November 12, 1881. My pond is situated near the source of a fine creek.

GROWTH.—November 25, 1882, my carp were 18 inches long and weighed 3 pounds.

REPRODUCTION.—The carp have done very well, and they produced young last summer.

THE CREEK STOCKED.—In August, 1882, in consequence of a very heavy rain, my pond rose 7 inches and overflowed. Some large and some small carp escaped into the creek below. Some time after the dam broke a man caught, with a dip-net, from the creek at some distance below my pond, 50 young carp and 1 large one.

667. *Statement of J. M. Courtright, Wilkes Barre, Luzerne Co., Pa., Nov.* 9, 1882.

DISPOSITION OF CARP RECEIVED.—Last fall I received 20 carp and put 16 in my pond, but kept 4 in my fish-box until spring before I put them in. They got very tame. I cannot see them this fall; am afraid something has caught them.

668. *Statement of C. W. Heydrick, Carleton, Mercer Co., Pa., Jan.* 27, 1883.

VITALITY.—Yesterday I received a consignment of 20 carp in a bucket containing about one gallon of water, one-half of which was frozen. Fifteen were in good condition. Five of the fish were firmly imbedded in the ice, and when released were apparently dead. I at once changed them into a bucket of fresh water and by careful manipulation I succeeded in restoring all, so that they are now out of danger. One of them was pretty near gone. It showed no signs of life for over 3 hours after I received it. I opened its gills with a needle and inflated its lungs by blowing in its mouth, and then placed it under water and manipulated it to imitate the operation of breathing—this operation I repeated several times at intervals for three hours until all were restored.

669. *Statement of B. F. Milford, Centretown, Mercer Co., Pa., Sept.* 29, 1882.

DISPOSITION OF CARP RECEIVED.—In the fall of 1881 I received 26 small carp and put them in a pond 75 by 150 feet, with a muddy bottom. Thirteen of them died in the winter.

GROWTH.—This spring they were about 3 inches long. On September 22d I examined them again and found that the remaining 13 averaged 14 inches in length and 3 pounds in weight.

670. *Statement of J. C. Offutt, Leesburg, Mercer Co., Pa., Oct.* 9, 1882.

GROWTH AND REPRODUCTION.—I have a nice lot of young carp which number from 300 to 400. They were hatched about the 25th to the 28th. My success surpasses all expectation. The 1 or 2 old ones are regular old whales.

671. *Statement of Henry Edenburn, West Middlesex, Mercer Co., Pa., Sept.* 16, 1882.

REPRODUCTION.—My fish are doing well. I have 2,000 young ones in my pond at this time.

672. *Statement of A. Spanogle, Lewistown, Mifflin Co., Pa., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received in June, 1883, and the 20 received last fall I placed in a pond 45 by 85 feet, having a depth of from 3 to 4 feet and a muddy bottom. I have made an addition to the pond of 35 square feet, and also from 1 to 2 feet in depth where the water leaves the pond.

PLANTS.—Frog-spittle grows in the pond and various kinds of grass around its edges.

ENEMIES.—I have caught most of the suckers and minnows that inhabit the pond.

FOOD.—I feed bread and curd occasionally. They do not want artificial food at this season of the year as there is enough natural food in the pond.

GROWTH.—I caught 2 carp in the fall of 1882 that weighed, respectively, 5 and 7 pounds. I have seen 6 of the original carp at one time, but as I cannot draw off all the water I am unable to give the exact number. They are in a healthy condition. There are young fish in the pond, but it is not known whether they are carp or not.

673. *Statement of G. H. Steinmetz, Norristown, Montgomery Co., Pa., Nov.* 5, 1883.

GROWTH.—Some time since I shot a carp which proved to be 25 inches long and to weigh $7\frac{3}{4}$ pounds. At the time of the shooting it was near the shore in the long grass and weeds looking for vegetable matter.

HABITS.—I do not think it of a carnivorous nature, as I have seen no attempt on its part to catch minnows. On opening the stomach I found the food in a very much decomposed state, consisting of a dark pulpy mass with a few pieces of worms. I consider the carp a vegetable feeder.

674. *Statement of Maurice C. Luckenbach, Bethlehem, Northampton Co., Pa., Dec.* 1, 1883.

GROWTH.—In March of this year I put a few carp into a small pond as an experiment. They were between 3 and 4 inches in length. I saw, so to say, nothing of them, excepting occasionally one would be seen to leap out of the water, when it was learned that they were of fair size. A few days ago several came to the surface dead from impure water running into the stream from a powder-mill. We immediately netted out the remaining live ones, 5 in all. I weighed 2 of the dead ones, evidently a male and female. They weighed 1¾ and 2¼ pounds. The growth of the fish astonished everybody. They were evidently mirror carp, as they had no scales on the sides, only along the backbone and a few scattered at the tail and belly.

675. *Statement of Robert Crane,* 112 *South Fourth St., Philadelphia, Pa., Feb.* 23, 1884.

DISPOSITION OF CARP RECEIVED.—The carp received in the fall of 1882 have done handsomely.

ENEMIES.—Snapping-turtles, water-snakes, fish-hawks, &c., took some of the carp.

GROWTH.—Our pond is in good condition, and the carp in it, some 35, wintered and came out this spring in good shape. They did not grow much during the winter. October 24, 1883, I estimated them to weigh about 1½ pounds and to average about 14 inches in length.

676. *Statement of Milton P. Peirce,* 14 *South Del. Ave., Philadelphia, Pa., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 30 carp received in 1879 and the 2 lots received subsequently I put in several small ponds, originally prepared for trout but quite unsuitable for carp. The natural temperature is 50° F., which can be regulated as well as the flow of water. The quantity of water that flows into the pond is a little more than is consumed by evaporation.

PLANTS.—Lilies (*nymphæa odorata*), *myriophyllum*, and other plants grow in the pond.

ENEMIES.—A few small, common frogs inhabit the pond. I shoot the water-snakes, snapping-turtles, minks, and kingfishers when they appear.

FOOD.—I give the carp no artificial food. But when preparing them for market or table, I shall place them in wire-bottom vats, and feed them on boiled sugar-corn.

GROWTH.—The 5 original carp remaining are from 15 to 18 inches in length. Other ponds which I built expressly for carp contain 2-year old carp which average over 2 feet in length.

REPRODUCTION.—In the ponds which are supplied by cold water I have a large number of young all the way up to 12 or more inches, and much larger ones in the ponds built especially for carp.

DISPOSITION OF YOUNG.—I have stocked other ponds with fry.

DIFFICULTIES.—Some of the original carp were stolen, and others killed by minks, kingfishers, and snakes.

RESUSCITATION OF APPARENTLY DEAD CARP.—From a lot of 1,200 carp one of my assistants threw out 110 which he supposed to be dead. I do not think they were dead, but only torpid, for one was left floating in the tank when it was replaced in the store. A small boy called who was going on the street-cars to a distant part of the city [Philadelphia]. The mechanics gave him the supposed dead carp, which he wrapped in a piece of paper and placed in his pocket to show to his chum. After reaching his destination and playing awhile, the two boys passed into a room where the goldfish tank stood, when he thought of his carp. The boys thought they would give the lady of the house a surprise, and so placed the carp in the tank. An hour or two later the lady discovered a strange fish swimming in her aquarium in an erratic manner, and, upon inquiry, learned from the boys the almost incredible facts. Two weeks later she called and related them to me, saying that the carp was well, lively, eating readily, and growing rapidly.—March 31, 1882.

677. *Statement of Milton P. Peirce,* 323 *Walnut St., Philadelphia, Pa., Sept.,* 18, 1884.

GROWTH.—Carp were placed in a pond at League Island in January, 1883, and when deposited were about 4 inches in length, having been hatched the summer before. Several specimens were captured to-day, not one of which was less than 3½ pounds in weight and 19 inches in length. The heaviest one weighed 4 pounds and 10 ounces, and measured 21 inches in length and 14 inches in girth. It was claimed that the fish grow large and thrive without any special care.

EDIBLE QUALITIES.—I have recently eaten carp, plainly fried, with no trimmings except a little butter. I consider them second only to the salmon family.

678. *Statement of Edward W. Taxis, 60 N. Sixth St., Philadelphia, Pa., June* 6, 1884.

CARP IN THE DELAWARE.—A carp 15 inches long was taken in a gill-net in the Delaware River yesterday morning. With goldfish and others it now sports in the tank at my office. The fact that several of them have been caught in the Delaware this season is conclusive evidence that, with proper protection, they will multiply indefinitely, and thus add another to the many sources of American food supply.

EDIBLE QUALITIES AND GAMINESS.—The carp does not equal the black bass either in gaminess when hooked or in its table qualities. When hooked it is somewhat resistant, and when properly served for food is far from being despicable.

679. *Statement of Gus. A. Wimmer, Philadelphia, Philadelphia Co., Pa., Sept.* 22, 1882.

FOOD.—When a boy I resided with my uncle on a large farm near Liepsic in Saxony. My uncle had 3 good-sized ponds in which he raised nothing but carp, and which he fed to a large extent on the scrapings of the sheep-pen. The carp appeared to be very fond of these pellets, few of which ever reached the bottom of the pond. I have seldom seen carp shoot around in the water as lively as those did when catching this food. The same experiment has been tried with the carp in one of the ponds in Paoli, Chester Valley, with the same result. My uncle stated that the carp secured much nourishment therefrom and grew fat thereby.

GROWTH.—The carp placed in a pond in Chester Valley about one year ago have been found to weigh 1¼ pounds.

680. *Statement of John Cockrane, Shamokin Dam, Snyder Co., Pa., Sept.* 8, 1884.

GROWTH AND REPRODUCTION.—The 20 carp received about 2 years ago now weigh from 3 to 4 pounds each, and measure from 14 to 16 inches in length.

I have about 2,000 young, from 1½ to 4 inches long, to sell. They are beauties.

681. *Statement of Samuel Barclay, Lavansville, Somerset Co., Pa., July* 16, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 scale carp received in December, 1880, I put in the milk-trough in the spring-house, as my pond was not completed. A few only survived the winter. The 15 received in April, 1882, and the 15 received in March, 1883, I placed in a pond 60 feet wide by 11 rods long, tapering to a point. It has a depth all the way up to 7 feet, and a bottom of mud and sod. It is usually supplied by 1½-inch stream of spring water, but in wet seasons the flow is sufficient to run over the entire width of the dam to the height of 1½ inches. There are brushes in the shallows of the pond. The water is warm in summer.

PLANTS,—Glade-grass grows in the pond, and I intend to plant creek-bulrushes in it.

ENEMIES.—A few common frogs and 1 full-grown snake, but no turtle nor other fish than carp, inhabit the pond. But in another pond are found catfish, sun-fish, suckers, and plenty of snakes, snapping-turtles, and muskrats.

FOOD.—I do not feed the carp.

GROWTH.—The few original carp remaining average 16 inches in length and are as large as shad. I saw 7 of the other old carp swimming among the brush yesterday afternoon. They appeared to be about 14 inches long and to weigh from 2½ to 3 pounds each. I do not expect any young this season.

MISCELLANEOUS.—I intend to prepare the other pond for carp, as its water seems especially adapted to them. It is 6 feet deep. I have several sites on which ponds could be easily constructed.

682. *Statement of Zina A. Lindsey, Montrose, Susquehanna Co., Pa., Jan.* 19, 1884.

DISPOSITION OF CARP RECEIVED.—The carp I received last spring I put in my pond. In a few days I looked for them and could not find them. I found, however, 2 large spotted lizards. I killed them, but that did not save the carp. Next time I will put them in a box protected by wire screens and feed them until they are large.

683. *Statement of D. O. Bower, Laurelton, Union Co., Pa., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received on June 2, 1880, I put in a half-acre pond, with a depth of from 2 to 5 feet, and a bottom of clay and gravel. A flow of one square foot of mountain spring water passes through the pond. The water is fresh during the summer, and warm in the winter.

PLANTS AND ENEMIES.—Six different kinds of plants grow in the pond. It contains no other fish, turtle, nor frogs, but I think minks sometimes visit it.

FOOD.—Daily, I feed the carp on lettuce, sweet corn, boiled rice, wheat, and various kinds of vegetable, but they would not eat much.

DIFFICULTIES.—When 9 inches long the carp were stolen by minks, I suppose. If I can get more carp, I will make my pond larger and more secure.

684. *Statement of J. C. Grundy, Lewisburg, Union Co., Pa., July* 31, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received in the fall of 1880 and the 20 received in 1882 I put in a pond covering 30 square feet, having a depth of from 3 inches to 3 feet, and a muddy bottom. The water is warm, and only about 1 inch flows through it in dry seasons.

ENEMIES.—Frogs, but no other fish than carp, inhabit the pond.

FOOD.—I give the carp bread and lettuce once a week.

GROWTH.—The 7 of the second lot of carp remaining average about 3 pounds. They are doing remarkably well and grow rapidly. Carp will be the cheapest food that can be raised. I have seen no young yet.

DIFFICULTIES.—Muskrats destroyed all of the original carp.

685. *Statement of Samuel Speechley, Coal Hill, Venango Co., Pa., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 carp received on November 13, 1880, I placed in about an $\frac{1}{8}$-acre pond, having a depth of from 2 to 6 feet and a muddy bottom. A spring supplies the pond with water.

PLANTS AND ENEMIES.—Grass grows around the edges of the pond. Frogs inhabit it.

FOOD.—I feed stale bread occasionally.

GROWTH.—There are from 8 to 10 carp remaining, which are from 15 to 18 inches long and weigh from 3 to 5 pounds.

REPRODUCTION.—There are a great many young in the pond, which are from 4 to 8 inches in length and weigh from $\frac{1}{4}$ to $\frac{1}{2}$ pound. I drained the pond in August, 1882, when many young from 1 to 4 inches in length were to be seen.

686. *Statement of P. R. Gray, Franklin, Venango Co., Pa., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—The carp I received I put in a pool in a small run, where there were some small chubs. The carp all died in a short time after being placed in the pool.

687. *Statement of George M. Ramsey, M. D., Clokey, Washington Co., Pa., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—The 8 mirror carp received on July 7, 1880, the 15 scale carp received in November, 1881, and the 50 leather carp received in the fall of 1882 I placed in a pond having a diameter of about 60 feet and a muddy bottom. Hard limestone water from a small spring feeds the pond, which is from 70° to 85°.

PLANTS AND ENEMIES.—The pond is full of swamp-grass, turtles, muskrats, snakes, frogs, but no other fish than carp inhabit it.

FOOD.—I give the carp bread occasionally.

GROWTH.—The one original mirror carp remaining is 24 inches long and very fat. The 3 scale carp remaining are fully as large as the 1 original mirror carp, and are also 24 inches in length. There remain 40 leather carp of the third lot, which are from 16 to 18 inches long.

DIFFICULTIES.—Mud-turtles destroyed all of the original carp but one, and all of the second lot but 3. Craw-fish, muskrats, and turtles, are very troublesome.

MISCELLANEOUS.—I am at a loss to know why the carp do not propagate.

688. *Statement of John S. Knox, East Finley, Washington Co., Pa., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp sent in November, 1880, were frozen when received. In 1882 I received 20 more, and placed them in a pond 40 by 70 feet, with a depth of 6 feet and a soft clay bottom. A small stream supplies the pond with a sufficient supply of fresh water.

PLANTS AND ENEMIES.—Swamp-grass grows in the pond. It contains no other fish. I killed 3 turtles which I found in it.

FOOD.—I give the carp bread daily.

GROWTH.—The carp average 8 inches in length. Last spring there were 6 remaining.

In the fall of 1882, the gentleman in whose pond I placed my carp bought 26 carp 4 inches in length. They now average 12 inches in length and 16 ounces in weight.

689. *Statement of John Gardner, Eldersville, Washington Co., Pa., July* 28, 1884.

GROWTH.—A year ago I placed in a pond supplied with spring water 40 scale carp, measuring from 3 to 5 inches in length. On June 9, 1884, I drew my pond and found 36 fish from 8 to 16 inches long. I have seen no young yet.

690. *Statement of J. Shan Margerum, Washington, Washington Co., Pa., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—The 18 mirror carp received on October 27, 1880, I put in a pond 30 feet in diameter, having a depth of 3 feet and a miry bottom. A 2-inch stream from a never-failing spring supplies the pond. It never freezes over in winter.

PLANTS.—Blue grass grows around the edges of the pond.

ENEMIES.—Nothing that disturbs the carp inhabits the pond.

FOOD.—The carp come to the surface for bread and cheese, which they take like pigs. I feed weekly.

GROWTH.—The 13 carp remaining are from 22 to 25 inches in length and weigh from 6 to 8 pounds. Last September they weighed $4\frac{1}{2}$ pounds, and the largest was 20 inches long. The carp are much admired.

REPRODUCTION.—There are bushels of young in the pond, which are from 2 to 14 inches long. They first spawned in 1882. The largest weigh from $1\frac{1}{2}$ to 2 pounds. Carp culture has been very successful here where they have been unmolested by other fish, muskrats, and turtles.

DISPOSITION OF YOUNG.—I have stocked other waters with the fry.

DIFFICULTIES.—The cause of the death of a few carp this spring is unknown, unless it be that there were too many fish in the pond for the quantity of water.

VALUE.—They may be grown with but little labor, expense, or risk, and at a profit that will make their cultivation very remunerative, especially to farmers, who are often seriously inconvenienced to procure fresh meat, and to whom the fish would be a most useful and agreeable substitute. There is no reason why every neighborhood in the county should not contain a well-stocked pond that would furnish cheap and nourishing food to the people. The growth of the fish is so rapid, and their fecundity is so great, that they can be raised with very little cost, and hence can be sold at a great profit. Many of the farmers have shown their enterprise by rearing the improved breeds of chickens, turkeys, ducks, and geese, and they could raise fish, when once prepared for it, with less cost and labor.

EXHIBITION OF CARP.—I have just exhibited the three varieties of carp at our county fair. The specimens varied in length from 1 to 22 inches, the age of the latter being 2 years. There are some only 1 year old, while others were apparently of only a few weeks' growth.

691. *Statement of E. P. Gibbons, West Brownsville, Washington Co., Pa., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The 15 carp received in November, 1880, and the 2 mirror carp that I subsequently bought I put in 2 ponds, respectively 40 by 75 feet and 40 by 90 feet, with a depth of 3 feet in the centers, getting shallower nearer the shores. The mud is thick on the bottoms. A $1\frac{1}{2}$-inch stream of brook and half that quantity of spring water supply the ponds. In mid-summer the temperature is 84°.

PLANTS.—Both of the ponds are bordered with swamp-grass. A dense growth of water-fern is in the smaller pond, while the larger one is bare of vegetation.

ENEMIES.—An abundance of frogs inhabit the pond, but it contains no other fish than carp.

FOOD.—The water-fern in the smaller pond affords the carp a plentiful supply of food. The carp in the larger pond eat ravenously and are fed daily on table refuse and garden vegetables, and weekly on beef blood.

GROWTH.—There are 4 original carp remaining. In the summer of 1881 the carp increased in size from $2\frac{1}{2}$ or 3 inches to 16 inches, and in the summer of 1882 only 2 inches had been added to their length since the former season. In that time they gained much in weight. They now measure from 18 to 20 inches in length.

REPRODUCTION.—The 800 young that were spawned last year are from 6 to 10 inches long. The ponds are now swarming with this summer's young.

DISPOSITION OF YOUNG.—I have disposed of 300 young to stock other ponds.

DIFFICULTIES.—I fear the frogs, which it seems I am unlikely to free the ponds of, eat the spawn. All but the 4 original carp fell a prey to muskrats, turtles, and water-snakes that formerly infested my ponds.

MISCELLANEOUS.—Before carp can be cultivated successfully their enemies must be subdued. Their culture is attended with little difficulties, and the pleasure, to say nothing of the profit, far outweighs the trouble.

692. *Statement of Duncan McAlister, Sardis, Westmoreland Co., Pa., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 pairs of carp received in 1879 I put in a pond covering about ½ acre, with a depth of from 6 inches to 6 feet, and a muddy bottom. It received a plentiful supply of moderately cool water from a large spring and from some underdrains from fields.

PLANTS AND ENEMIES.—Common grass grows in the pond. The carp were placed in a pond with other fish, but I have now rid it of enemies.

FOOD.—I gave the carp bread, daily.

DIFFICULTIES.—During the winter of 1879 and 1880 my carp did well, only 3 out of the 20 dying, but in June, 1880, some boys seined my pond and destroyed all my fish, leaving a good many dead ones on the banks and adjoining field.

I desire more carp, as I have enlarged and cleaned out the pond.

693. *Statement of John H. Riedel, Dallastown, York Co., Pa., Nov.* 3, 1882.

GROWTH.—The carp that Mr. William Neff got last fall now weigh 1½ pounds.

694. *Statement of John B. Gemmill, New Park, York Co., Pa., Oct.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received 21 carp in November, 1881, and 15 January 3, 1883. I put the first lot in a pond sloping gradually to 5 feet in depth, with a muddy bottom. It is supplied with 4,000 gallons of water daily. I put the other lot in pond number 2, which is 45 by 120 feet, with a muddy bottom.

PLANTS AND ENEMIES.—It contains bulrushes and various grasses. There are no other fish, but some frogs, and I killed two snappers in pond number 1.

FOOD.—We occasionally give them corn-bread, corn-dough, boiled potatoes, raw potatoes, and boiled sweet-corn. They grow right along on good, natural food, of which there is plenty.

GROWTH.—There are 11 left of the first lot, which average in weight from 3 to 4 pounds each. The largest weigh 4½ pounds, and measure 17 inches in length. In May I caught one which is now as large as a Susquehannah shad—say 5 pounds. There are no young yet. November 2, 1882, the carp were from 13 to 15 inches long, and weighed from 1 to 1½ pounds.

HOW TO CATCH CARP.—I caught one in May with hook and line and common anglingworm. They bite elegantly.

MISCELLANEOUS.—There is no trouble in raising carp in water of the right temperature. I intend erecting two more ponds, and am satisfied carp-raising will be a success with me.

695. *A. C. Krueger, Wrightsville, York Co., Pa., July* 22, 1884.

CARP IN SUSQUEHANNA RIVER.—A carp weighing about 4 pounds was taken in a set-net below the Columbia dam on the Susquehanna. It had doubtless escaped from some private pond, but may have been in the river some time.

696. *Statement of David Strickler, York, York Co., Pa., Aug.* 9, 1883.

DISPOSITION OF CARP RECEIVED.—I received 8 carp on June 3, 1880, 16 scale carp in fall of 1880, and in the fall of 1881 40 more carp. The 36 sent Mr. John T. Williams in the fall of 1880, and the 20 sent my son in the fall of 1882 were put in my ponds with the carp sent directly to me. The smaller pond is 83 feet long and from 5 to 25 feet wide; the larger 114 feet long and from 10 to 52 feet wide, having a depth of from 6 inches to 6 feet, and a muddy bottom. This summer about 10 gallons of water flows through the ponds per minute. In the smaller pond the temperature at the inlet is 64° and 72° at warmest part; the temperature of the larger pond at the inlet is 74°, at warmest part from 78° to 80°, and at the bottom 72°.

PLANTS.—Water-lilies and various kinds of plants and grass grow in the pond.

ENEMIES.—Small frogs, water-snakes, eels, and many tadpoles but no turtles nor other fish than carp inhabit the larger pond. I still fight the eels, water-snakes, and frogs. In the lower pond, bass, catfish, and eels are found.

FOOD.—I give the carp wheat, corn, corn meal, shipstuff, cheese, boiled vegetables, and house flies.

GROWTH.—Last April, the remaining carp of the original lot weighed $2\frac{1}{2}$ pounds. Of the 52 received by Mr. Williams and myself in 1880, 36 remain, and only from 8 to 10 of the last 3 lots. I have seen no young yet.

CARP IN THE SUSQUEHANNA.—Last fall a mirror carp was caught in the Susquehanna River, near the Maryland State line, and weighed $1\frac{1}{2}$ pounds, and measured 15 inches in length. It was very lean, having been in a box without food during the entire winter. I obtained it at a price of $2.50, to mate with my old carp, but I now fear they are not mates.

DIFFICULTIES.—My carp would have done much better had not the water in my ponds been so deep and so cold. A salmon that was in the pond before I placed the carp in devoured 6 of the original carp within 24 hours. The other 2 disappeared, and were not again seen until the following fall, when they were found in my lower pond with bass, catfish and eels. I cannot account for the disappearance of so many from the other lots of carp unless eels and water-snakes destroyed them. Eels are very difficult to get rid of, and the only way in which I succeeded was, after draining the pond, to let it remain dry for 3 months. It is said that they will crawl up an embankment to get into a pond.

MISCELLANEOUS.—I have spent much money and time upon carp culture, and I now have my ponds in a better condition than ever before. I intend to construct another one this fall. My water is suitable now, but the same cannot be said of the ground. The carp cannot escape from the pond, and floods never interfere.

697. *Statement of David Strickler, York, York Co., Pa., Dec.* 6, 1883.

GROWTH.—I have not drawn my ponds,but will give a full report when I do. I have 2 fish that may weigh 4 or 5 pounds. I think they made more growth the past summer than before, owing to being in a better pond.

698. *Statement of John T. Williams, Jr., York, York Co., Pa., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The 31 carp received in October, 1881, I put in a pond 30 by 50 feet, with a depth of from 1 to 5 feet, and a bottom of clay and rock.

ENEMIES.—Catfish, sun-fish, and common frogs are found in the pond. I do not feed the carp.

GROWTH.—The carp average 11 inches in length. There are no young yet.

DIFFICULTIES.—Poachers visit the pond. I cannot drain the pond to the bottom.

RHODE ISLAND.

699. *Statement of Alex. G. Sanford, Warren, Bristol Co., R. I., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—I received 75 carp about November 1, 1881. My pond is 100 feet long by 50 feet broad, and flows back 300 feet in length by 25 feet in width during about 9 months of the year. It has a muddy bottom.

PLANTS AND ENEMIES.—It contains lilies, flags, and several other kinds of water plants. It also contains frogs, and we have seen small turtles and small eels in it.

FOOD.—No food has been given, the pond seeming to contain enough.

GROWTH AND REPRODUCTION.—I should think there were about 50 original carp from $1\frac{1}{4}$ to 2 pounds weight each. The young when last seen were about $\frac{3}{4}$ of an inch long.

SOUTH CAROLINA.

700. *Statement of J. M. Cane, Elko, Barnwell Co., S. C., Oct.* 11, 1881.

FOOD.—I feed the carp, received last January, daily on bread and find that they are very fond of it.

GROWTH.—They have grown very fast and are now about 20 inches long.

EDIBLE QUALITIES.—I have taken one out of my pond and find it to be a very nice table fish, I believe the very best fish I ever tasted.

HOW TO CATCH CARP.—I caught a carp with a hook baited with corn-bread, though I must say that they are not easily caught in that way.

701. *Statement of S. B. Massey, Chester C. H., Chester Co., S. C.,* 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received in January, 1880, I placed in pond fed by springs and having a blue muddy bottom.

GROWTH.—The 20 original carp are now from 6 to 8 inches long and weigh from ¾ to 1 pound each.

MISCELLANEOUS.—Our native black perch and blue catfish are far superior as pond fish and can be cultivated with better results than the carp.

702. *Statement of F. Miller, Hartsville, Darlington Co., S. C., Oct.* 14, 1881.

DISPOSITION OF CARP RECEIVED.—February 15, 1881, I received 17 young carp in good condition and immediately placed them in a pond previously prepared for them. This pond was about 30 by 40 feet, and was excavated so as to slope gradually from very shallow water at the edge to 4 feet deep in the center. The water is supplied from a branch, which though a very small stream has been unfailing. The pond is inclosed with high palings and is protected in the usual manner from undesirable fish and other intruders.

PLANTS.—It is partially shaded by trees growing around and in it, and around the edges is a green border of rice and other water-plants.

FOOD.—I did not fail to put in the pond a plentiful supply of food consisting of cooked hominy and bread crumbs. Recently I have been delighted to see the fish. I succeeded in bringing them to the surface by throwing upon the water the common house flies which have been caught in a fly-trap and scalded. These, floating upon the water, attract the fish which I now bring up every day by the same means. They make a fine sight, swimming on the surface to get the bait.

GROWTH.—About the original number seem to be there and they have grown well. They were very lively and shy, but are becoming tame, as they are accustomed to the sight of visitors.

MISCELLANEOUS.—I feel sanguine that the carp will do well in such water as my pond contains, and I confidently expect good results with sufficient time.

703. *Statement of M. S. Walker, Edgefield C. H., Edgefield Co., S. C.*, 1883.

DISPOSITION OF CARP RECEIVED.—I placed in a pond the 15 carp received in December, 1881, and the 21 received in January, 1883. The soil of the pond is muddy.

PLANTS.—The pond has fine vegetation.

GROWTH.—On November 1, 1882, I drew my pond and found only 4 carp, weighing about 4 pounds each.

REPRODUCTION.—A great many young carp could be seen in April and May. They are doing fine.

704. *Statement of S. W. Bookhart, M. D., Blythewood, Fairfield Co., S. C., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 22 carp in January, 1883. My pond is from 3 to 5 feet deep, has muddy bottom, and is located on a spring branch which supplies a small quantity of water of moderate temperature.

PLANTS.—It contains lilies and various water-grasses.

ENEMIES.—There are a few perch which are intruders, and also some turtles. Our greatest difficulty will be from the depredations of turtles and moccasins.

FOOD.—I have given them no food, as they did not seem to need any.

GROWTH.—I have seen only one. That was caught in the stream below my pond last week. It measured 14 inches.

MISCELLANEOUS.—We are preparing 2 more ponds for other varieties of carp. From close observation of other people's ponds I can say from personal knowledge that the scale carp is the best fish for our culture that we know of.

705. *Statement of T. Henry Stokes, Alba, Greenville Co., S. C., Apr.*, 1883.

EDIBLE QUALITIES.—I regard the carp as a splendid table fish. It was so pronounced by a large number of ladies and gentlemen who partook of the fish on two separate occasions.

MISCELLANEOUS.—I have taken much pains in feeding my carp. I call them up with a small bell. They are very gentle.

706. *Statement of W. C. Cleveland, Greenville C. H., Greenville Co., Sept.*, 1881.

DISPOSITION OF CARP RECEIVED.—I placed the mirror carp received last February in a mill-pond covering about half an acre.

FOOD.—They were never fed on anything, except a little corn bread occasionally thrown to them.

GROWTH.—When the fish were about 8 months old I drew the pond and found about half the number placed therein. I was greatly surprised to find that they had grown from 2 inches to 18 inches in length in 8 months. They were about the same size, and weighed over 3 pounds.

707. *Statement of Alex. McBee, Greenville C. H., Greenville Co., S. C., Oct.* 28, 1881.

ENEMIES.—My pond has eels, catfish, and perch in it; they have destroyed most of the fish.

GROWTH.—I received in January last about 20 carp from 1 to 2 inches long. When I drew off my pond I caught 9 carp, 5 scale and 4 mirror, that measured 17 inches each and weighed from 4¼ to 4½ pounds. I have them now in a nice pond in which there are no other fish, and by feeding them I hope to have fish that will weigh from 12 to 15 pounds Why, my dear sir, they will, if well cared for, grow almost as fast as pumpkins.

708. *Statement of H. C. Markley, Greenville, C. H., Greenville Co., S. C., June* 16, 1882.

GROWTH.—I have some carp 14 months old that average from 10 to 14 inches in length. They are fine for their age.

709. *Statement of John W. Wood, Greenville C. H., Greenville Co., S. C., Jan.* 11, 1882.

DISPOSITION OF CARP PURCHASED.—The 200 scale carp which I procured last May from Griffin, Ga., at a cost of $35 per hundred, I placed in 2 ponds on small branches of clear, sweet spring water. The ponds are well located, every part being exposed to the sun and free from all impurities. They are kept free from other fish.

FOOD.—The ponds abound in natural food, and I feed the carp on meat scraps, crumbled crackers, and corn bread.

GROWTH.—My carp are growing finely. In May they were 1½ inches long, and now they average from 18 to 20 inches in length.

710. *Statement of W. T. Wood, Greenville C. H., Greenville Co., S. C., Jan.* 21, 1883.

GROWTH.—The scale carp received on May 29, 1881, were about 1 inch long. The following August they measured from 8 to 10 inches in length, and in July, 1882, they spawned being then 14 months old. In September, 1882, they measured from 18 to 25 inches in length.

MISCELLANEOUS.—My scale carp have surpassed in growth the mirror carp of this vicinity.

711. *Statement of Edward M. Boykin, M. D., Camden, Kershaw Co., S. C., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp three years ago and put them in a friend's pond, but they were lost. I received 30 more later, and put a part of them in a fine piece of water 2 acres in extent, varying from 2 to 8 feet in depth. It is supplied with from 130 to 150 gallons of water per minute from a constant spring.

PLANTS.—It is filled with aquatic grasses pecular to southern inland waters.

ENEMIES.—The loss of the first lot was attributed to craw-fish that certainly had attacked them.

FOOD.—We give them bread principally.

GROWTH.—Eighteen months after depositing the first lot in my friend's pond it was drawn off, and there was a fine carp found weighing 5 pounds. This was the only one left of the lot, and was given to the agricultural department at Columbia, S. C. The pond was drained and cleared out and 15 or 20 small fish were put in, which are doing well.

MISCELLANEOUS.—I have just finished a pond at my residence for breeding carp with the intention of giving it special attention. With ordinary attention success is certain. Some 25 years ago I paid considerable attention to fish-ponds, dealing with our native varieties. It was very beautiful and very interesting but did not pay. It was all very well while the fish were all the same size, but breeding predaceous fish in close waters is impossible.

712. *Statement of J. A. Wright, Laurens C. H., Laurens Co., S. C., Aug.* 16, 1881.

FOOD.—I have not fed the carp more than a dozen times since they were put in the ponds in February last.

GROWTH.—I dragged my pond yesterday and caught 3 carp, one of which was 14 inches long and the most beautiful thing I ever saw. These fish were not more than 3 inches in length when planted. They seem to be very fat.

713. *Statement of H. L. Machem, Line Creek, Laurens Co., S. C., Feb.* 9, 1882.

GROWTH.—I received 18 carp about 5 inches long in December, 1880, and placed them in my pond early the following January. I drew off the water from the pond about a month ago, and by seining caught 17 carp which averaged a fraction more than 4 pounds. The largest carp weighed 5½, and the smallest 3 pounds. They were beauties.

714. *Statement of G. L. Martin, Line Creek, Laurens Co., S. C., June* 26, 1882.

GROWTH.—Mr. H. L. Machem took from his pond, June 23, a carp weighing 5 pounds and measuring 19 inches in length and 13 inches around the largest part of the body.

REPRODUCTION.—This gentleman thinks he has thousands of young ones.

EDIBLE QUALITIES.—The fish was prepared and a party of six gentlemen invited to dine the next day. After partaking to their satisfaction it was their unanimous vote that it was a good table fish, and that the reports to the contrary are without foundation in fact.

715. *Statement of M. L. Kyzer, Barr's Landing, Lexington Co., S. C.*, 1883.

GROWTH.—In April, 1883, I received 20 carp which were about 2 inches long. They have done well and are now from 12 to 15 inches long, and will weigh from 2 to 3 pounds. I am well pleased with them and think they are a success.

716. *Statement of A. D. Bates, Batesburg, Lexington Co., S. C.*, 1883.

DISPOSITION OF CARP RECEIVED.—I placed the 12 carp received in 1879 in a pond covering ½ acre, with a maximum depth of 8 feet and a black, muddy bottom.

GROWTH.—In 1881, two years after I received my carp, I drew off my pond and found 8 of the original ones. They were 25 inches in length and weighed from 6 to 7½ pounds.

REPRODUCTION.—When I drew off my pond I also found 40 small carp about 14 inches long and weighing 1¼ pounds each. I replaced 15 in the pond, and on draining the pond in the spring of 1882 I found all I had put back weighing from 6 to 10 pounds each. There were also 400 young that weighed from ¼ to 1 pound. My carp spawned about April 20, 1883.

DISPOSITION OF CARP.—After drawing the water in 1881 I ate all the large carp and gave away the young ones except 15.

SALES.—I have sold 460 carp for $223.50.

717. *Statement of A. D. Bates, Batesburg, Lexington Co., S. C., Oct.* 20, 1883.

DISPOSITION OF CARP.—When I drew my pond, April 11, 1883, I took 11 of the fish and put them in a highland pond in front of my house. This pond covers from 6 to 7 acres when full, is supplied by rain, and has a maximum depth of 3½ feet. During the hottest days in summer the water in the pond is unpleasant to the hand. I also placed in this pond 9 of the young carp which I first saw in my other pond April 20.

GROWTH.—A few days ago I took the 11 carp out of my highland pond, as it was nearly dry. The carp weighed 1 pound each when put in this pond and remained there 6 months. A few days ago these fish weighed from 6 to 7½ pounds each. The largest one of the 9 young carp now weighs 3 pounds, this remarkable growth being attained in 6 months. Another one of these 6 months' old carp measures 17 inches in length and weighs 2½ pounds.

718. *Statement of N. G. Cooner, Batesburg, Lexington Co., S. C.*, 1883.

DISPOSITION OF CARP RECEIVED.—I placed the 5 carp received in 1881 and the 20 received in 1882 in a pond covering ⅘ of an acre, having a depth of 5 feet and supplied by spring water.

REPRODUCTION.—I now have numbers of young carp.

719. *Statement of Gen. Paul Quattlebaum, Leesville, Lexington Co., S. C., July* 30, 1884.

DISPOSITION OF CARP RECEIVED.—I placed in my pond the 38 scale carp received in February, 1883, and the 20 carp received in June, 1883, as well as 27 carp belonging to the State Fish Commission received on February 16, 1883.

GROWTH.—The scale carp were from 12 to 15 inches long in 1883.

REPRODUCTION.—Some of the State Fish Commission's fish spawned as early as April 12, 1883, and there are young in the pond that are from 10 to 12 inches long. The young fish hatched early last May are now 5 or 6 inches long.

CATCHING CARP WITH A HOOK.—I use a beardless hook for two reasons. It can be taken from the mouth of a fish with greater ease and does less injury. I often catch carp for visitors to examine, and then return them to their native element. They may also be removed to other ponds in good condition. For catching small fry I use no cork; for large fish I prefer one, with lead enough on the line to sink the hook a few inches in the water, but they will take it at any depth. Late in the afternoon or early in the morning is the best time in warm weather. When the sun is shining brightly, and its rays strike deep down into the waters, the carp retires from his feeding-grounds and remains at rest until the shade of the evening lures him from his quiet retreat. On warm cloudy days, when trained to artificial feeding, the carp may be caught at any hour, but less readily about noon. It is a waste of time to angle for them in cold weather. It is well known that the carp declines all food in freezing weather, and that the appetite varies with the temperature of the water to a certain degree. In my ponds, near Leesville, I can catch either kind of carp as above stated from April to December. I train them to come to the surface of the water for food so as to enjoy the pleasure of seeing them scramble for it. The cheapest of light bread, made of middlings or shorts, expressly for the fish, is what I use. The same answers for baiting the hook, but a piece of waffle, cut the right size for the fish you desire to catch, is better, being tougher and not so easily taken from the hook by the fish. I first collect the fish together by throwing in a handful of small bits of bread—say one-half inch square—then I drop in my hook, attached to a strong line at the end of a suitable cane, and in less than a minute I am almost sure to bring a carp to grass. More time is generally consumed in putting the bait on the hook and taking the fish off of it than in luring him to take the bait.

CONSTRUCTION OF A CARP POND.—The man who builds a dam across a small stream and lets all the water, often increased by floods of rain, flow in and through the pond and over an ordinary waste-weir, is greatly deceived if he thinks he has a pond at all adapted to hatching or even raising carp successfully. My pond is supplied with water from a pond at its head, in which I do not propose to rear fish of any kind. The upper pond has an outlet through a ditch of sufficient capacity to let all the surplus water pass along the side of the lower or carp pond. The rain water from the hillside is cut off by a ditch running near the margin of the pond, and all the water that enters it is conducted below the dam. This ditch, together with a little canal on the other side of the pond, and a plank fence from one to the other at the dam form a complete bar to turtles and other depredators that would like to enter such rich pastures. I was very particular to construct the inlet as well as the outlet, so that a fish can neither enter nor escape, deeming it, however, of more importance that all other fish should be kept out than that a few carp should escape; for if the depredators be kept out the pond will be soon overstocked with young carp.

720. *Statement of A. Y. W. Glymph, Glymphville, Newberry Co., S. C., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp about 1878. My pond is 25 feet deep; has sandy and rocky bottom. It is subject to overflow by Brand River. This has occurred twice since I put the carp in.

PLANTS.—It contains a plant which is called here bonnet.

ENEMIES.—There are trout, suckers, catfish, bream, white and black goggle-eye, and minnows.

FOOD.—I have given them none.

GROWTH.—I have not caught any carp yet, but I see some very large ones.

721. *Statement of J. N. Rutherford, Walhalla, Oconee Co., S. C.*, 1883.

ENEMIES.—I am annoyed a great deal with muskrats, which make the carp very shy, though I do not think they eat the carp.

FOOD.—I feed my carp on bread, corn, potatoes, cabbage, lettuce, fruit, blackberries, and grapes, all of which they eat very greedily.

MISCELLANEOUS.—I am well pleased with my prospects in carp culture. I cannot find but 9 fish of the 20 which I deposited in my pond in December, 1881.

722. *Statement of James A. Peterkin, Fort Notte, Orangeburg Co., S. C., Aug.* 9, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp in December, 188[illegible], and put them in a pond covering 2 acres with water averaging from 2 to 15 feet in depth. It is supplied by a small stream which flows continuously.

PLANTS.—There are several varieties of grass around the edge.

ENEMIES.—There are small perch and frogs in abundance, and it is impossible to get rid of them.

GROWTH.—We had one for dinner in June which weighed 10 pounds and measured 24 inches in length. There are still 8 to 10 of them.

REPRODUCTION.—I am not able to say how many young they have produced; not very many as I think that the perch destroyed them. I still hope that I have some young ones.

DIFFICULTIES.—I built a separate pond for them, but the weir rotted out before I knew it and the carp escaped into the main pond, which is the reason for their not doing better. I have no doubt that they will do well in this section if properly managed.

723. *Statement of E. H. Bates, Maynard, Pickens Co., S. C., July* 31, 1883.

FOOD.—I train my carp to come for food at the sound of a bell. I was first enabled to do this by throwing flies on the surface of the water. In this way they learned to be gentle.

GROWTH.—The carp received February 9, 1883, are doing well and are from 6 to 10 inches long. I purpose constructing one or two more ponds.

724. *Statement of A. P. Butler, Commissioner of Agriculture, Columbia, Richland Co., S. C., Oct.* 18, 1880.

GROWTH.—I have the most encouraging reports of the carp distributed last November. Some are 10 inches in length and weigh 1 pound.

725. *Statement of C. J. Huske, Superintendent of Fish and Fisheries, Columbia, Richland Co., S. C., Oct.* 31, 1881.

DISPOSITION OF CARP RECEIVED.—I received a supply of fish last winter and placed them in a pond situated on a 4-acre lot, which had been purchased for carp culture. About as large an area as is now covered by water can be taken in and the pond made twice its present size.

GROWTH.—I drew the pond off September 27 and found about 170 fine carp from 10 inches upward, the largest being 21½ inches in length and weighing 4½ pounds. We expect the fish to spawn next spring; and with the number of stock fish we now have we may look for a large supply of young fish for distribution annually.

726. *Statement of C. J. Huske, Columbia, Richland, Co., S. C., June* 1, 1882.

DISPOSITION OF CARP RECEIVED.—Without a single exception where parties have been prepared to take their carp, they were delivered in good condition. Last year we distributed 2,200 and this year 4,500. Those distributed a year ago have done so well that our citizens feel that they can undertake carp culture with reasonable hope of success. Four express shipments all came through from Washington in fine condition and the carp were shipped throughout the State at a cost of 3 cents apiece. Very few died on our hands.

GROWTH.—The State carp ponds at Columbia, which have been enlarged during the winter, contain 200 carp 2 years old, weighing from 2 to 5 pounds each.

727. *Statement of C. J. Huske, Columbia, Richland Co., S. C., Aug.* 18, 1883.

REPRODUCTION.—The carp have done well in this State. Where they were distributed 2 or 3 years ago the ponds are now full of young. All the neighboring farmers have seen the practical results of their introduction, are highly pleased, and are determined to have carp ponds on their farms. The number of applications is daily increasing, and it will be difficult to estimate how many the total will be at the close of the season.

728. *Statement of W. P. Hoy, Millville, Spartanburg Co., S. C.*, 1883.

GROWTH.—I am highly pleased with the carp. I drew my pond on April 25, 1883, and the fish were from 4 to 6 inches long. I measured them again in August, when they were 14 inches long, having grown 8 inches in less than 4 months.

729. *Statement of G. W. Tuck, Shoally, Spartanburgh Co., S. C., July* 7, 1883.

DISPOSITION OF CARP RECEIVED.—About the middle of last February I procured 15 small carp and placed them in a pond prepared especially for their reception; then for 4 months I saw no trace of them, and concluded I was only raising frogs in abundance.

GROWTH AND REPRODUCTION.—About June 15, I succeeded in capturing one of the original 15 carp, which, to my surprise, measured 13 inches in length and weighed 2 pounds. I also have to-day at least hundreds and perhaps thousands of young carp from ½ inch to 2½ inches long.

730. *Statement of S. P. Garrison, Fort Mill, York Co., S. C.*, 1883.

DISPOSITION OF CARP RECEIVED.—I placed the carp received in 1881 in a ¼-acre pond having a depth of from 1 to 4 feet.

REPRODUCTION.—There are a large number of young in my pond.

731. *Statement of R. E. Guthrie, Guthriesville, York Co., S. C., June* 3, 1881.

ENEMIES.—All of my carp but 2 were evidently destroyed soon after they were planted. The animals that did this work were "cooters," eels, and some other enemies of the finny tribe.

GROWTH.—I drew off my pond June 3, and found that the 2 carp remaining had made a growth of 10 inches in length and were very thick and chubby. A few days ago we caught a carp 14 months old that was 17¾ inches long, 5 inches broad, 2½ inches thick, and weighed 3 pounds. This fish was from 3 to 4 inches long when planted.

EDIBLE QUALITIES.—To set the matter as to the edible qualities of carp finally at rest, Mr. John F. Hinson, of Guthriesville, S. C., and myself determined to test the matter with the frying-pan. Accordingly, Saturday last was appointed as the day for preparing one of the carp for the table and submitting it to the palates of a number of gentlemen competent to judge of the eating qualities of the finny tribe. The carp tested was of the mirror variety. It was cleansed by scalding, similar to the process of cleaning catfish. Upon cleaning, it presented as fine an appearance as a dressed shad. Served and placed on the table, it is the equal of any fish we have ever eaten and superior to the flavor of the many popular varieties. The eight persons who partook of it gave but one expression as to its merits as food, and that was that in respect to the texture of the flesh and flavor it is equal to any fresh-water fish known to our streams. Some of those who tried this fish had doubts as to the carp's eating qualities, but by this test these doubts were removed. It is palatable and all that could be desired by the lover of the red-horse and brook trout. The opinion seemed to prevail that these species somewhat resemble the carp in flavor.

732. *Statement of John F. Hinson, Guthriesville, York Co., S. C., Oct.*, 1881.

GROWTH.—I drew off my pond July 15 for the purpose of transferring my fish to another pond, and found 19 of the 20 carp planted last January. These were between 3 and four inches long when placed in the pond, and I find they have grown remarkably, the largest being 16 inches long and 6 inches broad and the smallest 10 inches in length.

FOOD.—I feed the carp regularly and have accustomed them to a feeding place, to which they repair at a given signal.

733. *Statement of Wm. B. Tewell, Rock Hill, York Co., S. C., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received some carp about 3 years ago, but lost all except 2 or 3, as I had to bring them a good way. I received 20 more 2 years ago and put them in a pond 50 by 300 feet, and 3 or 4 feet deep. It has a muddy bottom. There is very little water in summer, and it is warm.

PLANTS AND ENEMIES.—It contains wire-grass and bulrush. There are also a few perch and frogs in it.

FOOD.—I give them wheat, hominy, and bread.

GROWTH.—Two weeks ago I caught 3 which were about 22 inches long, and 37 from 10 to 12 inches long, and transferred them to another pond. The only difficulty has been a lack of water.

734. *Statement of John C. Witherspoon, Rock Hill, York Co., S. C.*, 1883.

GROWTH.—The carp furnished me in December, 1881, have grown beyond my expectation. None have died save one in April, injured by a muskrat. It would weigh 2 pounds and had eggs in it. I caught one in August which weighed 2¾, which also had eggs in it. Some of the larger fish would weigh from 4 to 5 pounds.

TENNESSEE.

735. *Statement of A. Campbell, McKenzie, Carroll Co., Tenn., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received in the fall of 1880 I placed in a pond covering 50 or more square yards, with a depth of 5 feet and a clayey bottom. It is only fed by rain water.

PLANTS AND ENEMIES.—There are no plants in the pond. There are toads, but no other fish than carp in it.

FOOD.—I give the carp corn, wheat, and bread occasionally.

GROWTH.—The 5 original carp remaining average from 12 to 15 inches in length.

DIFFICULTIES.—A flood of water allowed all the carp to escape except 5. On one of these there is an excrescence which causes it to appear as if its back is broken.

736. *Statement of E. C. Lewis, Sycamore, Cheatham Co., Tenn., Aug.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 pairs of carp I received in November, 1880, I put in a newly-constructed pond 20 by 50 yards, with a depth of from 3 to 4 feet and a muddy bottom. A small stream of spring water, the temperature of which varies with the atmosphere, runs through the pond.

PLANTS AND ENEMIES.—Cresses, lilies, and grasses grow in the pond. Turtles and frogs inhabit it.

DIFFICULTIES.—In the spring of 1881 I found only one carp, and that has since disappeared. I cannot account for this, as I killed all the turtles, &c., that I could find when I drained the pond. I have speculated as to whether the carp found in the spring of 1881 might have been the young of the old carp.

MISCELLANEOUS.—I now have 3 ponds, and desire another trial at carp culture.

737. *Statement of John Burger, Celina, Clay Co., Tenn., Dec.*, 1883.

GROWTH.—I took from my tank this week a 2-year old carp which weighed $9\frac{3}{4}$ pounds. This is the largest carp known to have been taken from any tank in the country.

738. *Statement of A. J. and W. B. Baird, Nashville, Davidson Co., Tenn., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—We put the 5 pairs of carp received in November, 1880, in a pond 50 by 80 feet, with a depth of from 1 to 5 feet, and a rocky bottom covered with mud to the depth of 6 inches. About a $1\frac{1}{2}$-inch stream from 2 springs feeds the pond. It has a temperature of 60°.

PLANTS.—In May the surface of the water is covered by a green spore, which in June develops in a 2-leaved plant $\frac{1}{8}$ inch in diameter. It has a root an inch long, which extends downward.

ENEMIES.—No other fish than carp inhabit the pond. Occasionally a frog and turtle are seen, but an effort is made to rid the pond of them.

FOOD.—The carp provide for themselves, but we give bread when we desire to see them.

GROWTH.—A carp caught last September weighed $4\frac{1}{4}$ pounds. They will now weigh from 6 to 7 pounds. We have all of the original carp except the one we ate.

REPRODUCTION.—There are an abundance of young in the pond which are from $\frac{1}{2}$ to 10 inches in length. The 10-inch carp are a year old. We have been so successful in the culture of carp that we have constructed a pond 5 times as large as the old one. They are both well stocked.

MISCELLANEOUS.—We went to the pond this evening, and in a few minutes took a bountiful supply for the table. We had company, and all pronounced the carp excellent. Any complaint as to quality must certainly be founded in not knowing how to prepare them for the table.

739. *Statement of Dr. J. H. Callender, Nashville, Davidson Co., Tenn., Dec.* 9, 1880.

FOOD.—Every care has been taken of the carp. I have fed them regularly and have not allowed any one to disturb them. Consequently they are very tame and come at a call for their food.

GROWTH.—The carp distributed here last year are doing remarkably well. Then they did not exceed $1\frac{1}{2}$ inches in length and looked very puny. The other day I caught 5 of my smallest carp, each of which weighed $1\frac{1}{2}$ pounds, and livelier and finer looking fish could not be found. They have not spawned yet.

740. *Statement of George B. Crockett, Nashville, Davidson Co., Tenn., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—The carp received in November, 1880, were placed in a natural pond of Dr. John B. Crockett, Brentwood, Williamson County, Tennessee. The pond covers about ¾ acres, with a varying depth, and a muddy and sandy bottom. It is supplied by rain and part of the year by spring water.

ENEMIES.—No other fish than carp inhabit the pond.

MISCELLANEOUS.—The pond is so large and deep that I have seen none of the carp since they were placed in it, though I have visited it often since. Others, however, have seen them.

741. *Statement of Duncan B. Dorris, Nashville, Davidson Co., Tenn., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 4 pair of carp received 3 years ago I put in a small pond. They were frozen to death by an unexpected cold snap. Nearly all of them who have received carp have been wonderfully successful. The climate of Tennessee is especially adapted to their culture.

742. *Statement of George Eberhardt, Nashville, Davidson Co., Tenn., Aug.* 3, 1884.

GROWTH AND REPRODUCTION.—The 50 or 60 young carp received about 2 years ago have grown to an enormous size, and the increase in the numbers of young is beyond belief.

743. *Statement of H. B. Gray, Nashville, Davidson Co., Tenn., Aug.* 3, 1884.

REPRODUCTION.—In April, 1884, I placed in my pond 5 scale and 4 leather adult carp. A few days ago I seined my pond and found 500 young, averaging in length from 3 to 6 inches, while at least 50 of them measured 10 inches in length.

EDIBLE QUALITIES—The flesh of carp is excellent food, especially when they are allowed to remain in a small pond of clear spring water before serving for the table.

744. *Statement of Frank W. Green, Nashville, Davidson Co., Tenn., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I put the 17 scale carp received in February, 1879, in a pond 48 by 98 feet, walled around with cemented stone and having a depth of 5 feet and a bottom of solid rock. Over the bottom sediment has accumulated to the depth of from 8 to 10 inches. Rain water flows into the pond over blue grass sward. Enough is collected to last during dry seasons, and when all the small streams dried up 2 years ago my pond afforded a sufficient supply of water for from 300 to 400 head of stock, besides furnishing water for perishing plants.

PLANTS.—A vegetable mold forms on the surface very fast, and is eaten by the carp almost as rapidly as formed.

ENEMIES.—A few bull-frogs infest the pond. I have no means of ascertaining how the catfish that were in my pond when I put the carp there were destroyed. In the spring of 1882, from 3 to 6 catfish could be frequently seen floating upon the surface in a disemboweled condition, while their bodies were not decayed. I think the carp destroyed them.

FOOD.—I put in my pond the solid food of the refuse from my table and kitchen. The carp eat and thrive like pigs. The success of carp culture is in knowing how to feed them.

GROWTH.—Each of the 12 original carp remaining are 17 inches long and weigh 6 pounds.

REPRODUCTION.—There are thousands and thousands of fry in the pond. One-half bushel of young can be caught at one haul of a seine. They range in size from 1 to 15 inches. Parties whom I supplied with carp in 1881 now have their ponds full of young. My success shows that any one can have a carp pond where rain falls. My fish spawned the second summer after I received them.

DISPOSITION OF YOUNG.—I gave the Fish Commissioner of Tennessee 3 barrels of fry, which, I suppose, contained thousands. I have also sold $600 worth of young, and expressed them all over the State. I sell them for $25 per hundred, or 25 cents each.

HARDIHOOD.—I sent 50 carp from 6 to 8 inches long to Newberry, S. C., and although they were 4 days on their way, they reached their destination in safety. I ship 25 in a 6 gallon tin bucket made for the purpose.

HOW TO CATCH CARP.—In catching carp you do not have the trouble of digging worms and catching minnows; you simply bait a hook, attached to a leader, with stiff flour dough in such a quantity as will cover it entirely. They take it as soon as it

reaches the water. They bite as freely as trout or perch, always catch clear, and never swallow the hook.

745. *Statement of George Hart, Nashville, Davidson Co., Tenn., Aug.* 14, 1884.

HOW TO CATCH CARP.—Yesterday I caught from my pond, with a net, 3 carp, one of which was 18 inches long and 10 inches around, and was only 2 years old. The rest of the carp were so lively and jumped so high that I was unable to take more.

746. *Statement of Ira P. Jones, Nashville, Davidson Co., Tenn., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—On November 25, 1880, I received 10 carp which I gave to John C. Ferris, esq., of this county. It required some little time for him to prepare his bass pond for the carp, and I think he only placed 6 in the water. He has since removed, and I am not able to give any of the facts as to the result of this experiment.

The 20 carp received December 2, 1880, I gave to Mr. S. M. Wilson, Tennessee Ridge, Houston County, Tennessee, which he put in a pond 15 by 30 feet. During the heat of the following summer the water was dried up and the carp all lost.

MISCELLANEOUS.—Generally the carp you have sent to this part of Tennessee have grown rapidly and in some cases multiplied largely, showing that the water and the climate are well adapted to them. Mr. Frank W. Green, of this city, has been very successful, being able to sell many fry for more than a year and a half.

747. *Statement of Louis C. Lischy, Nashville, Davidson Co., Tenn., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received in the winter of 1881 I put in a pond nearly circular in form, with a diameter of about 100 feet, a depth of 6 feet in the center, and a clay bottom. Water from a spring branch is turned into the pond at will. The water freezes to the thickness of 2 or 3 inches during some winters.

PLANTS.—A few willows and various kinds of grass grow around the edges of the pond.

ENEMIES.—A few frogs, but no other fish than carp inhabit the pond.

FOOD.—I do not feed the carp.

GROWTH.—I have all of the original carp unless some were carried off in the recent very destructive overflow. The carp as seen in the water appear to be from 12 to 15 inches long.

REPRODUCTION.—The young in the pond are plentiful and are of various sizes.

DIFFICULTIES.—I find it difficult to prevent overflows.

748. *Statement of J. E. Warner, Nashville, Davidson Co., Tenn., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received in 1881 I placed in a pond 25 by 50 feet, having an average depth of 4½ feet and a rocky bottom. About 150 gallons of water, at a temperature of 53° F., flows through the pond per minute.

PLANTS.—Mosses alone grow in the pond. It is inhabited by nothing that disturbs the carp.

FOOD.—I feed the carp entirely on vegetable food, about twice a week.

GROWTH.—The 6 original carp remaining average one pound and are about 11 inches long.

REPRODUCTION.—There are many young in the pond, which average about 3 inches in length.

DISPOSITION OF YOUNG.—I have given away some of the fry.

DIFFICULTIES.—The spring water that supplies the pond is too cold and pure for carp. Water-snakes trouble them.

749. *Statement of A. F. Whitman, Nashville, Davidson Co., Tenn., Aug.* 13, 1883.

DISPOSITION OF CARP RECEIVED.—The 26 carp received in November, 1880, I placed in a pond 25 by 250 feet, having a depth of 2½ feet and a smooth, rocky bottom covered with mud to the depth of from 6 to 10 inches. From 10 to 20 gallons of spring water per minute flow through the pond in dry seasons and from 100 to 200 gallons in spring. It has a temperature of from 55° to 60°.

PLANTS AND ENEMIES.—Plants grow only on the edges of the pond. A few frogs, but no other fish than carp inhabit it. There were turtles formerly in it, but none now.

FOOD.—I feed the carp on bread irregularly, generally when my friends desire to see them.

GROWTH.—There are from 18 to 20 of the original carp remaining. I caught one last summer that weighed fully 3 pounds. They do not seem to have increased much in weight since.

REPRODUCTION.—There are from 50 to 100 young of last year's spawning, but I cannot estimate the number of this year's. The yearlings weigh from 14 to 16 ounces. This year's fry were 2 inches long in June.

DIFFICULTIES.—Several of the carp were destroyed by turtles the first year. In the spring of 1881 I found one with 2 inches of its tail eaten off. It is difficult to keep my pond from leaking.

750. *Statement of B. F. Woodward, Nashville, Davidson Co., Tenn., July* 22, 1883.

DISPOSITION OF CARP RECEIVED.—I placed the 6 carp received in December, 1881, in an open cistern in a green-house. The cistern is 6 by 34 feet, is 5 feet deep, and has a loose gravelly bottom. It is kept full by rain-water, which has a temperature of 70° to-day, and never less than 45°. The pond contains no plants.

ENEMIES.—One bull-frog inhabits the cistern.

FOOD.—I feed the carp on bread and worms from potted plants. I occasionally throw leaves of various plants in the cistern.

GROWTH.—I have never weighed them, but suppose the 6 carp remaining will weigh from 10 to 12 pounds each, and average more than 1 foot in length.

MISCELLANEOUS.—I intend to move the carp to a pond next year.

751. *Statement of Marcus J. Wright, Nashville, Davidson Co., Tenn., Aug.* 14, 1884.

GROWTH.—A carp weighing 5 pounds was recently taken from one of the pools at the State capitol, when the pools were being cleaned.

752. *Statement of John F. Guntrel, Colesburg, Dickson Co., Tenn., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The 5 pairs of carp received in December, 1880, I placed in a newly constructed pond, but, unfortunately, the first hard rain broke the dam and allowed all of them to escape. Since then I have rebuilt my dam and increased the number of the ponds. The upper pond covers $\frac{3}{8}$ of an acre, and has withstood the heavy rains for the last 2 years. The middle one covers about $\frac{1}{5}$ of an acre, and the lower about $4\frac{1}{2}$ acres. The upper and lower pond have each one spring, but the greatest amount of water is supplied by 500 acres of land which serve as a watershed. My observation during the last 2 years has convinced me that the ponds retain a sufficient amount of water during the entire year. The maximum depth of the ponds is 9 feet, and gets shallower nearer the shore. The bottoms of the ponds are composed of heavy yellow and red clay mixed with iron ore.

PLANTS.—Plants indigenous here grow in the pond.

FOOD.—The drainage from the large watershed is sufficient to sustain quite a number of carp.

753. *Statement of S. J. Alexander, Macon, Fayette Co., Tenn., July* 3, 1883.

DISPOSITION OF CARP RECEIVED.—The scale carp received in January, 1881, and the leather carp in November, 1881, were placed in a new pond 15 months ago. I have another pond, from $\frac{1}{2}$ foot to 8 feet deep, which contains lilies but no moss. In it I have black and blue catfish, buffalo, suckers, trout, and 5 kinds of perch. I expect to make another pond for carp this summer, and place the three ponds and grass lot under a wire fence, with shade trees.

FOOD.—Both old and young carp come to the surface of the water for bread.

GROWTH.—Mr. J. A. Clay Reed caught with a seine, November 1, 1882, a carp that was $20\frac{1}{2}$ inches long. Mr. John F. Porter, Galloway, Tenn., transferred his leather carp in October, 1882, to his new pond, when one of the fish was $16\frac{1}{2}$ inches long.

REPRODUCTION.—Last summer (1882) I saw only 4 young ones. But I now have quite a quantity of young carp from 1 to 6 inches long. Last Saturday I crushed four soda crackers and threw the same on the surface of the water for them. For 15 minutes the young carp could be seen taking the food and lining the water for a space of from 5 to 20 feet.

754. *Statement of William H. Fariss, Macon, Fayette Co., Tenn., Sept.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—The 18 scale carp received on January 7, 1881, and the lot of leather or king carp received subsequently I put in a pond which is 450 feet in circumference and 75 feet front. It has an average depth of 6 feet, and a bottom composed of mud and gravel. Cold water from a 1-acre watershed feeds the pond.

PLANTS.—Herd-grass and clover grow in the pond. No other fish than carp inhabit it.
FOOD.—I give the carp wheat, grain, and refuse from the table from 3 to 4 times a week.
GROWTH.—I have 12 original carp, each of which weighs about 5 pounds.
REPRODUCTION.—I have only seen from 5 to 6 young, which weigh from $\frac{1}{4}$ to $\frac{1}{2}$ pound each.
EDIBLE QUALITIES.—I have eaten 2 carp, the edible qualities of which were very fine. They are much sought after here.
DIFFICULTIES.—I lost 6 original carp the summer I received them.

755. *Statement of J. W. Mewborn, Macon, Fayette Co., Tenn., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 24 carp received in January, 1880, and those received subsequently, I put in a still-water pond, 40 by 60 feet, having a depth of 5 feet and a muddy bottom. The pond contains no plants.
ENEMIES.—A few catfish and perch were in the pond before I received the carp.
FOOD.—Irregularly I feed grits, corn and flour-bread, cooked vegetables, &c.
GROWTH AND REPRODUCTION.—The 10 original carp remaining average from $1\frac{1}{2}$ to 2 pounds. It is impossible to tell the number of young there are in the pond.
MISCELLANEOUS.—Carp can be raised as easily as pigs or chickens. It is possible for every one, even in this inland country, to have fish as plentiful as barn-yard fowls by constructing a carp pond. I paid a visit to Mr. S. J. Alexander's carp pond a few days since to see his carp fed. His pond is small. As the carp had never received a scare it was a treat to see how gentle they were, rolling and tumbling in full view on the surface of the water in their scramble after food.

756. *Statement of Joe I. Rogers, Trenton, Gibson Co., Tenn., Apr.* 25, 1883.

GROWTH.—The carp which I placed in my 3 ponds October 10, 1880, now measure 22 inches in length and average 5 pounds in weight. My fish did not spawn last summer. I feed them with meal.

757. *Statement of Rogers & Sons, Trenton, Gibson Co., Tenn., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—We received 10 carp on November 10, 1880, 130 on November 28, 1880, and 10 on October 12, 1881. We placed the carp in 3 ponds, each of which has a muddy bottom. The first pond covers $\frac{1}{4}$ of an acre, having a depth of 6 feet and a flow of 25 gallons of water per minute, at a temperature of 60°. The second pond covers $2\frac{1}{2}$ acres, with a depth of $5\frac{1}{2}$ feet, and 30 gallons of water flowing through it per minute. Its temperature is also 60°. The third, a breeding pond, covers $1\frac{3}{4}$ acres, and has a depth of $2\frac{1}{2}$ feet, and a temperature of 80°. They contain no plants.
ENEMIES.—Catfish, perch, bull-frogs, and snapping-turtles inhabit the pond and have given the carp some trouble.
FOOD.—We give the carp corn-bread, meal, wheat, and mill-sweepings every two days.
GROWTH.—We moved 100 of the old carp to the breeding-pond this spring. They were from 18 to 24 inches long, and weighed from $2\frac{1}{2}$ to 5 pounds. Our carp are healthy and are doing well.
REPRODUCTION.—The carp spawned this year for the first time. We estimate the number of young at 50,000, which average 5 inches in length, and weigh from 3 to 4 ounces.

758. *Statement of John F. Humberd, Newmansville, Greene Co., Tenn., Mar.* 21, 1883.

REPRODUCTION.—The carp placed in my pond 18 months ago are increasing fast.

759. *Statement of J. D. Hyberger, Timber Ridge, Greene Co., Tenn., May* 27, 1882.

GROWTH.—I have just made an examination of the carp received in November, 1881, and find 9 remaining in my dam. They were 3 inches long when received and have now attained an average length of 9 inches and a weight of $\frac{1}{2}$ pound each. Their increase in size for the 6 months is almost incredible. They are perfect beauties, and I am more than pleased with them.

760. *Statement of T. Marshall Williams, Morristown, Hamblen Co., Tenn., April* 21, 1882.

GROWTH AND ENEMIES.—The carp received last fall were placed in a pond covering $\frac{3}{8}$ acre and having a depth of 5 feet, but they were not again seen until last March.

Their growth even during the winter months was rapid. The 4 which escaped the maw of the mallard duck that infested the pond did well, and grew at an astonishing rate up to a few days ago, when a kingfisher killed 2 of them.

761. *Statement of J. T. Low, Saulsbury, Hardeman Co., Tenn., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The 33 carp received from a gentleman in Mississippi in January, 1881, and the 25 received from the U. S. Fish Commission in February, 1881, I put in a pond covering about an acre, with a depth of 15 feet and a muddy bottom. It is formed in a ravine below a spring, and has a daily supply of 20 barrels of water. There is no surplus water except when it rains. It did not freeze over last winter. The pond contains no plants nor other fish than carp.

FOOD.—I give the carp bread and meal weekly.

GROWTH.—Each of the 20 original carp remaining weigh from 1 to 6 pounds. I have taken 2 that weigh 6 pounds each. I have given 8 of the old carp to a neighbor.

REPRODUCTION.—The pond is well stocked with young, which are from 4 to 6 inches in length.

DIFFICULTIES.—I found 2 dead carp in the pond, which appeared to have been snagged.

MISCELLANEOUS.—Every farmer who does not live near a river or lake should have a carp pond.

762. *Statement of H. B. Wright, Saulsbury, Hardeman Co., Tenn., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The total number of carp received and placed in my pond in January, 1881, by myself and others was 65. The pond is crescent-shaped, and covers 1½ acres. It is 18 feet deep in the center, and the spring water that flows in it is less in summer than that consumed by evaporation. The temperature varies with the depth of the water, and is lukewarm in summer at the ends of the pond where the water is shallow.

PLANTS.—A few bulrushes grow in the pond.

ENEMIES.—Bull-frogs, catfish, perch, suckers, &c., inhabit the pond.

FOOD.—I feed the carp mostly on bread, but not oftener than twice a week.

GROWTH.—I judge from the appearance of the carp remaining that they will weigh 10 or more pounds. My carp are perfectly healthy, and grow like pigs.

REPRODUCTION.—There are a great many young in the pond, which weigh from $\frac{1}{16}$ ounce to 2 pounds.

EDIBLE QUALITIES.—We skin them and fry in lard; not cotton-seed oil. They eat pretty well to those unused to the fine fish of North Carolina waters. A neighbor says they are as good as he ever ate. I think they will be a blessing to the country.

763. *Statement of J. M. Hudson, Paris, Henry Co., Tenn., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The 25 carp received in November, 1880, I put in a ½-acre pond having a muddy bottom. Its maximum depth is 6 feet, and it gets shallower nearer the shores. I intend to increase the depth of the water by raising the levee. Rain water alone feeds the pond.

PLANTS.—Five or six large oak trees and a small clump of willows grow in the pond. A variety of grapes and weeds is to be found upon the adjoining hill.

ENEMIES.—An abundance of bull-frogs, toads, and some snakes, but no other fish than carp, inhabit the pond.

FOOD.—I have not fed the carp, supposing there was a sufficient quantity of natural food in the pond.

GROWTH.—In July, 1882, there were original carp remaining, some of which were more than 2 feet long. They have grown rapidly. I have not counted them since, but frequently see from 2 to 3 at a time. I have seen no young yet.

DIFFICULTIES.—My pond dried up in the summer of 1882, but since then the pond has and will continue to have a sufficient supply of water. I found 5 dead carp floating on the surface of the water in July, 1882, and I once thought that they were injured by a thief while attempting to gig them with a sharp stick.

764. *Statement of J. N. Thompson, Paris, Henry Co., Tenn., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—The 22 carp received in 1881, I put in a ¼-acre pond having an average depth of 3 feet, and a muddy bottom. Rain-water alone supplies the pond.

ENEMIES.—Mud-turtles, frogs, &c., inhabit the pond.

FOOD.—I give the carp corn-bread, sometimes 3 times a week, and then again only twice a month.

GROWTH.—The carp will average about 4 pounds. I have caught no young yet, and do not know how many there are.

DIFFICULTIES.—My pond broke twice, and each time allowed some of the carp to escape.

MISCELLANEOUS.—I desire more carp to stock my other pond. I think they are the fish for the ponds of this country.

765. *Statement of S. M. Wilson, Tennessee Ridge, Houston Co., Tenn., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received on November 19, 1880, I placed in a pond covering from 1 to 1½ acres, having a depth of from 1 to 5 feet, and a muddy bottom. Water flows into the pond in spring until it reaches a depth of 7 feet. It has a warm temperature.

PLANTS AND ENEMIES.—All sorts of swamp weeds and grasses indigenous here grow in the pond. A few bull-frogs, but no other fish than carp, inhabit it. There are no turtles.

FOOD.—An abundance of food washed from the adjacent hillsides. I gave them no artificial food.

GROWTH.—The carp were only from 3 to 5 inches long when I placed them in the pond, and in 8 months averaged from 3½ to 4 pounds and were from 14 to 16 inches long. They were fat and grew rapidly.

DIFFICULTIES.—My pond was very low during a very dry season 2 years ago, and a poacher, seeing the carp, killed them.

MISCELLANEOUS.—Could I get more carp, I am certain I could cultivate them successfully.

766. *Statement of J. M. McAdoo, McEwen, Humphreys Co., Tenn., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The 7 carp received in the winter of 1880 I put in a ¼-acre pond having a depth of 5 feet. It is supplied with rain water which gets warm in summer.

PLANTS AND ENEMIES.—Moss collects on the surface of the water. Perch, frogs, and a few turtles inhabit the pond.

FOOD.—I give the carp the sweepings of a corn and flour mill.

GROWTH.—The carp were 2 feet long and weighed 6 pounds each a year ago. I saw one a few days ago that was about 3 feet long and weighed about 12 or 15 pounds. I have seen but 3 of the carp since they were put in the pond. The 2 carp that I caught were full of eggs, but I have seen no young yet.

767. *Statement of A. G. Keisling, Bull Run, Knox Co., Tenn., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I placed 10 carp of the lot received March 8, 1883, in a box or pen made of plank and the other 10 in a 1-acre pond. It has 5 feet of water at its maximum depth, getting shallower toward the shore. The water in my pond passes through a weir from a mill-race. Eight days after the carp were received I removed those in the pen to the pond. I saw some of them occasionally, but not since May 1.

ENEMIES.—I fear that the kingfishers and two ducks, and perhaps turtles, all of which I have caught in the pond, have destroyed the carp.

FOOD.—From time to time I have placed food in the pond but have never seen the carp take it.

768. *Statement of Cullen & Newman, Knoxville, Knox Co., Tenn., June* 11, 1881.

GROWTH.—The 20 small carp received in the latter part of December, 1880, have within 6 months attained a weight of 1¼ pounds. I notice that some grow much faster than others.

769. *Statement of Curtis Cullen, Knoxville, Knox Co., Tenn., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 received in the fall of 1880, and the 20 received subsequently, I placed in a pond having a diameter of 100 feet, a depth of from 1 to 5 feet, and a muddy bottom. The water is warm and the supply small. None has flowed into the pond for 3 months. I intend to construct a windmill to supply it with a sufficient quantity of water.

PLANTS.—A large supply of water-grasses grow in the pond.

ENEMIES.—I kill all the frogs I can, and dip out all their eggs which I see. I have taken out of the pond all other fish except carp.

FOOD.—I give the carp bread, cabbage, cooked potatoes, and refuse from the table daily, about sunset.

GROWTH.—One of the 11 original carp remaining weighed 5 pounds in March. The largest will now weigh from 6 to 6½ pounds.

REPRODUCTION.—This is the first year that the carp have spawned. The pond seems to be alive with young, which are from 2½ to 3 months old and measure from 4 to 5 inches in length.

DIFFICULTIES.—The pond has suffered for want of water. I lost 5 carp by placing them in a barrel when draining my pond.

MISCELLANEOUS.—I propose constructing a 5-acre pond this summer, and I will supply it with carp from the pond in which they are now kept. Carp are fine fish and every farmer should raise them for his table.

770. *Statement of S. M. Clayton, Cyruston, Lincoln Co., Tenn., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I put the 6 carp received on November 1, 1880, in a ½-acre pond with a depth of from 6 inches to 4 feet, and a muddy bottom. It has been increased to an acre. The supply of water depends upon the seasons. At this date the water does not run out of the pond. My ponds number 4, and were made last fall.

PLANTS.—Grasses grow on the edges of the pond. I need some better plants in it.

ENEMIES.—Branch minnows, frogs, turtles, and occasionally snakes are seen in it.

FOOD.—Once a day I give them refuse from the garden and kitchen, coarse ground corn and wheat, and green corn. They are also fond of biscuit.

GROWTH.—Without giving the original carp any artificial food they weighed 4 pounds each, and were 18 inches long in 10 months after being placed in my pond. There are only 4 of the old carp remaining. Last fall each of them weighed 10 pounds, and will now weigh 12½ pounds.

REPRODUCTION.—When hatched the fry are very small, and were it not for the head and eyes it would be difficult to see them. My carp commenced spawning in the spring of 1882, when 2 years old, but not being properly fixed, I only managed to keep about 2,000 of the fry. They now weigh 3 pounds, and are yearlings. There are many 6-inch young in the pond. The carp have spawned but once this year.

SALES.—I sold $115 worth of young, and have 600 left.

MISCELLANEOUS.—I have my spawners in a pond to themselves, as the other fish would devour their eggs. The eggs are adhesive and cling to anything they touch. All that fall to the ground are lost. In a warm place the eggs, which can be moved from one place to another, will hatch in from 6 to 12 days. I put brush and broom sedge in to catch the eggs. They seem to prefer the latter.

771. *Statement of John Y. Keith, Jackson, Madison Co., Tenn., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 pairs of carp received in November, 1879, and the 20 pairs received in 1881, I put in a 2-acre oblong-shaped pond, having a depth of from 2 to 6 feet, and a bottom composed of white and pipe clay. It is supplied only with water from the surrounding watersheds, and it has a temperature of 70° in summer.

PLANTS.—Water-lily, water-cress, calamus, yon-a-pin, water-mint, and flags grow in the pond.

ENEMIES.—Striped bass, black perch, red perch, yellow cat, and a few turtles and bull-frogs inhabit the pond.

FOOD.—I give the carp wheat and rye screenings, baked corn bread, vegetables, and sometimes shelled corn once a week.

GROWTH.—There are 7 pairs remaining of the carp first received, and 18 pairs received in 1881. There are 3 sizes of the old carp: the largest are from 7 to 9 pounds; the next largest from 3 to 4½ pounds, and the next from ½ to 2 pounds each.

REPRODUCTION.—There are a great many young of all sizes in the pond.

DISPOSITION OF YOUNG.—I have given young carp to my neighbors who have small ponds.

HOW TO CATCH CARP.—My carp bite at the hook.

DIFFICULTIES.—Poachers visit the pond and turtles also destroy the carp.

772. *Statement of E. A. Lindsey, Jackson, Madison Co., Tenn., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—The 18 carp received in 1880 and the 8 received in 1881 I placed, in a newly-constructed pond, 80 by 100 feet, with a clay bottom. The

natural drainage which supplies the pond with water has practically failed for two seasons.

PLANTS.—There are no plants in the pond.

ENEMIES.—Nothing of any consequence disturbs the carp.

FOOD.—I give the carp lettuce, bread, and mush every 2 or 3 days.

GROWTH.—The few original carp remaining average about 20 inches in length.

REPRODUCTION.—There are great numbers of young in the pond, and they weigh all the way up to 1 pound.

SALES.—I have supplied 3 of my neighbors with young.

DIFFICULTIES.—My pond does not properly hold water, and has suffered for the want of a sufficient supply. I purpose remedying the latter defect by means of a windmill and well.

773. *Statement of D. H. Parker, M. D., Medon, Madison Co., Tenn., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received a total of 45 carp in November, 1880 and February, 1881. I placed them in a ¼-acre pond, having a depth of 3½ feet, a muddy bottom, and 40 gallons of very cold spring water flowing through it per hour.

PLANTS.—A few pond-lilies, but no plants of any consequence, grow in the pond. Nothing that disturbs the carp inhabits it.

FOOD.—I give the carp bread, cabbage, and cooked Irish potatoes twice a week.

GROWTH.—The 8 original carp remaining weigh from 1 to 6 pounds. The leather carp are much the larger. I am satisfied that carp thrive a great deal better in stagnant than in spring or running water. My daughter has about 20 carp in stagnant water that are growing finely. I have seen no young yet.

DIFFICULTIES.—The kingfisher is the greatest enemy of the carp.

774. *Statement of H. F. Parker, Medon, Madison Co., Tenn., July* 31, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp received in October, 1880 and in January, 1881, I placed in a 2½-acre pond having a depth of from 1 to 6 feet and a very soft, muddy bottom. Six gallons of very cold water from never-failing springs in the pond flow through it per minute.

PLANTS.—Swamp-grasses grow in the pond where the water is 2 or 3 feet deep.

ENEMIES.—Bream, speckled perch, goggle-eye perch, catfish, bull-frogs, toads, and a few turtles inhabit the pond.

FOOD.—I give the carp stale-bread crumbs.

GROWTH.—The original carp weigh from 2½ to 3 pounds. I have seen no young yet.

DIFFICULTIES.—Turtles and muskrats disturb the carp.

MISCELLANEOUS.—The carp do not go into the mud in winter. I placed 2 carp in a small pond, but could never tame them. They are very shy—the wildest fish I ever saw.

775. *Statement of W. Hugh Brown, Spring Hill, Maury Co., Tenn., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received in December, 1880, and 20 in November, 1881 remained for 12 months, without any increase, in a small pond having a muddy bottom. They then got in an adjoining pond covering from 4 to 5 acres, and having a depth of from 6 inches to 12 feet, and a muddy, rocky, and gravelly bottom. The pond is supplied by a large spring. Large quantities of water, which in summer is moderately warm at the top but cold at the bottom, flow in and out of the pond. The carp can find water to suit them in the various temperatures of the pond.

PLANTS.—The carp seem to enjoy, and I frequently see them in the moss that grows in such great quantities in the pond.

ENEMIES.—White perch, white bass, large bull-frogs, turtles of every variety, quantities of muskrats, snakes, and mosquitoes in great profusion inhabit the pond.

FOOD.—As the carp find every thing in the pond that they desire, I give them no food.

GROWTH.—I have 9 of the original carp. I have never caught any, but from appearance judge that they weigh from 20 to 25 pounds each.

REPRODUCTION.—I do not know the number of young in the pond, but I am certain that there has been a great increase. They weigh from ½ to 1 pound.

MISCELLANEOUS.—My pond is finely adapted to carp culture.

776. *Statement of Rev. F. A. Thompson, Spring Hill, Maury Co., Tenn., May* 21, 1884.

DISPOSITION OF CARP RECEIVED.—I received 9 leather carp in November, 1880, and kept them in a box in the pond until March, 1881. I received 25 more in November,

1881. I placed them in a ¼-acre pond, having a muddy bottom and a depth all the way up to 4 feet. The pond is supplied by a stream of spring water, 2 feet wide and 1 inch deep, except in winter, when the supply is greater. It contains no plants.

ENEMIES.—Small minnows, frogs, and muskrats inhabit the pond, but there are no turtles at present.

FOOD.—I never fed the carp till last fall. I gave them about 1½ quarts of cooked corn-meal daily through the winter, but do not feed them now, as I have enlarged my pond.

GROWTH.—When I turned the carp into the pond in March, 1881, they weighed about 2 ounces, and were as large as a man's finger. In June, 1881, 3 months after they were taken out of the box, I drew off the water from the pond and caught the largest of the carp, which weighed 2 pounds and was more than 1 foot long. It was, however, accidentally killed by some boys throwing at a muskrat. I drew off the water again on November 8, 1881, and caught a carp (not the largest) which was 22 inches in length and weighed 7 pounds. This truly wonderful growth was attained without any food having been given the carp. There was little difference in the sizes of the 8 carp remaining at that date (November, 1881). I now have 13 old carp remaining. In March 1883, the original carp averaged from 10 to 12 pounds: one in particular weighed 11½ pounds. I suppose they weigh from 13 to 14 pounds. The young of 1882 weighed from 1 to 2 pounds in March, 1883, at which time 76 yearlings were taken out.

REPRODUCTION AND DISPOSITION OF YOUNG.—I placed about 3,000 young, from 3 to 6 inches long, in a newly constructed pond, covering 2 acres, this spring (1884). They grew very rapidly during the spring, and by this time are much larger than when I placed them in the pond.

EDIBLE QUALITIES.—We have eaten a few carp fried. Some liked them, while others thought they had a taste of mud. They are not equal to trout, perch, cat, &c.

DIFFICULTIES.—My carp have been healthy with the exception of an occasional sore, as if injured. Floods broke my new pond and allowed some of the young carp to escape.

MISCELLANEOUS.—I intend to use the old pond for breeding purposes exclusively. I am able to draw off the water at any time. I have another small pond, 6 by 60 feet, just below a clear spring, and in which I intend to place the carp I desire to eat. I will feed them on nice food, which, with pure water, I trust will make them edible at any season of the year. I desire some carp of the scale variety.

777. *Statement of Francis Pride, Cedar Hill, Robertson Co., Tenn., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 14 scale carp received on November 20, 1879, and 50 mirror, received subsequently, I put in 2 of the 5 apartments of my pond, having muddy bottoms and depths of from 1 to 4 feet. Forty gallons of cold, clear spring water flow through them per minute.

PLANTS AND ENEMIES.—Plants indigenous here grow in the pond. Native trout, black bass, a few turtles, and many frogs inhabit the other apartments of the pond.

FOOD.—I give the carp bread, curd, and various kinds of vegetable food two or three times a week.

GROWTH.—The 5 original carp are each about 2 feet long, and weigh from 10 to 15 pounds. A scale carp at 2 years old weighed 7½ pounds, and was 17½ inches in circumference, and 22½ inches long. The carp have been healthy.

REPRODUCTION.—This is the first year that the carp have spawned. The fry are innumerable, and, as they were hatched in June and the early part of this month, they are very small.

DIFFICULTIES.—As I could not keep the trout and the carp apart last year, the trout devoured many of the young carp. I have some of the carp so situated now that the trout can not disturb them. The last lot of 20 carp disappeared during the winter.

778. *Statement of George W. Walker, Springfield, Robertson Co., Tenn., Aug.* 11, 1883.

DISPOSITION OF CARP RECEIVED.—The 6 carp received in December, 1880, I put in a pond covering about ½ an acre, having a muddy bottom. The water is from 5 to 6 feet deep on the north and west sides of the pond for ⅔ of the entire pond, and is only from 15 to 20 inches deep on the east and west sides. Rain water supplies the pond, which is subject to a rise of 2 feet.

PLANTS.—The pond contains no plants, but around its edges grow swamp-grasses.

ENEMIES.—Since I drained the pond in 1880, and in 1881 when it drained itself, it has contained no other fish than carp. I kill the frogs and turtles as they appear.

FOOD.—The carp receive sustenance from the drainage of a barn-yard, in addition to the corn-bread I feed them.

GROWTH.—The carp remaining is about 18 inches long, and is of good size.

DIFFICULTIES.—My pond was dried up in May, 1881, and I found 3 of the carp floundering about in the mud. I moved them to a pit 10 feet square, 10 feet deep, with 4 feet of water in it. One morning in September I found one dead, while the others were lively and ate heartily. On the following morning I found another one dead. These 2 were the largest ones, being 9 inches long, proportionately large and fat. I removed the carp remaining to the pond, but have not fed it since. As I did not find but 3 carp when the pond was dried up in May, 1881, I think the others buried themselves in the mud which was then very soft, and 15 inches deep.

779. *Statement of N. Blackwell, M. D., Bartlett, Shelby Co., Tenn., Aug.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received on November 12, 1880, and 20 more on November 25, 1881, I put in an artificial pond covering about ¼ acre, with a depth of 4 feet, and a muddy bottom. The rain water which alone supplies the pond gets quite warm in summer.

PLANTS.—No plants grow in the pond, but a variety of weeds and grasses grow around its edges.

ENEMIES.—Frogs, but no other fish than carp inhabit the pond.

FOOD.—I feed the carp on flour-bread daily.

GROWTH.—The original carp remaining average about 5 pounds. All of the 30 carp that I received are in the pond except the 3 which I ate.

REPRODUCTION.—The carp did not spawn until they were 2 years old. A great number of young are in the pond. The yearlings are 13 inches long and weigh 2 pounds.

DISTRIBUTION OF YOUNG.—I supplied some of my neighbors with fry.

780. *Statement of N. F. Le Master*, 19 *Madison st., Memphis, Shelby Co., Tenn., Aug.* 9, 1883.

DISPOSITION OF CARP RECEIVED.—The 24 carp received in December, 1880, and the 12 received on January 1, 1883, I placed in a pond having a diamater of 100 feet, a depth of 4 feet, and a muddy bottom. The pond is so constructed as to retain all the water that may flow into it, except in exceedingly wet seasons.

PLANTS.—The pond is almost surrounded by swamp-willows, and around its edges grow 3 varities of succulent grasses.

ENEMIES.—A few speckle perch and numerous bull-frogs inhabit the pond.

FOOD.—I give the carp meal, corn-bread, pumpkins, and birds, and in winter I feed them about once a week.

GROWTH.—There are about ⅓ of the original carp remaining. They are from 18 to 24 inches in length, and from 4 to 6 inches in width, and weigh from 4 to 6 pounds. My carp are quite thrifty and grow very rapidly. Some of the last I received have grown 6 inches in as many months. I have seen no young yet.

DIFFICULTIES.—Poachers visited the pond and caught some of the original carp while I was absent from home.

781. *Statement of John G. King, Bristol, Sullivan Co., Tenn., Sept.* 21, 1883.

DISPOSITION OF CARP RECEIVED.—My carp were received November 26, 1881. They are in a pond of 3 acres, with a muddy bottom and fed by a large and pure limestone spring, the temperature being the same summer and winter.

GROWTH.—They weighed 2 pounds and 5 ounces, and were 15 inches long September 5, 1882. They now weigh from 8 to 12 pounds each.

REPRODUCTION.—I think they have spawned, as there are young in the pond, though they may be branch minnows.

782. *Statement of Dr. Thomas W. Roane, Covington, Tipton Co., Tenn., June* 27, 1884.

DISPOSITION OF CARP RECEIVED.—I placed the 40 carp received in November, 1881, and then 2 to 2½ inches long, in a pond 90 by 150 feet. The pond is supplied with an abundance of spring water, and is dug in a rich alluvial soil—the bed of an old pond filled up 20 years ago.

PLANTS.—The pond contains an abundance of vegetable growth.

FOOD.—I feed the carp occasionally on bread, fruit, vegetables, wheat, corn, and oats in the sheaf, all of which they devour greedily. They are now very tame. They come to feed in the afternoon, and eat bread, potatoes, cabbage, grain, and refuse from the kitchen greedily. They are to be seen sporting and leaping out of the water, biting off the succulent grass stalks with a snap of the jaws that sounds like pigs feeding.

GROWTH.—I never saw them or perceived any indication of their presence in the water until about June 1, 1882, when to my surprise and delight I found numbers of

them playing and feeding among the rank grass in shallow water. Their size amazed me, and at first glimpse of their backs I thought some one had put large catfish in my pond; but closer observation convinced me that these were my little carp, now grown to enormous fellows from 8 to 10 inches long and as thick as my two hands. I now have carp in my pond all the way up to 7 and 8 pounds.

REPRODUCTION.—The pond is crowded with young carp to such an extent that the old carp have no chance to take the bait, as the young instantly consume it whenever placed in the pond. The carp have multiplied and grown enormously.

DISPOSITION OF YOUNG.—I have supplied a few of my neighbors with young.

EDIBLE QUALITIES.—Each year I have had on my table one or two of the original carp, and consider them superior to any of our native fish. Their flesh is excellent, and the fattest I ever saw.

HOW TO CATCH CARP.—Last year I caught carp with worms, mush, and cotton ball, same as we use on a trot-line to catch buffalo-fish.

MISCELLANEOUS.—I am of opinion that carp spawn twice a year, May and September. I intend to enlarge my pond this summer.

783. *Statement of M. T. Peebles, Rose Hill, near Johnson City, Washington Co., Tenn., Nov. 24, 1883.*

DISPOSITION OF CARP RECEIVED.—I received 17 live scale carp December 22, 1882, but they presented evidence of bad treatment on the way. The next day I placed them in my pond, which has an admirable bed of mud on the bottom and appears well adapted to the life and growth of carp. My diary, kept with the most exact care, shows that 13 of the 17 had died before January 10, 1883. Careful and repeated observations from that time to the 1st of June, 1883, failed to discover the least trace of the 4 remaining. Consequently, on the 3d of April, 1883, I obtained from a gentleman in Nashville 28 carp, ranging in length from 6 to 10 inches, but the entire lot perished on the way. From June 20 to August 20 the temperature of the water stood at 82° to 85° F. It did not fall below 65° until the middle of October.

ENEMIES.—I did not make sufficient provision for their spawning, and did not protect them from their natural enemies. The pond was full of frogs and tadpoles, which destroyed the spawn and young fish.

GROWTH.—On the 30th of June, 1883, a little more than 6 months from their receipt, I drained the pond and found 4 fine fish from 8 to 10 inches long. Up to this time they had not been fed at all; but from this time on I fed them regularly every evening until the 12th of September, when I again drained the pond and found that the 4 fish had greatly increased in size.

REPRODUCTION.—The 28 dead carp which I received from the Nashville gentleman were from 6 to 10 inches in length, and had undoubtedly been hatched in May or June, 1882. They were 10 or 11 months old at this date. I cut them open and examined them microscopically. Seventeen of them were females and 11 males. It was perfectly manifest that the best of the 17 would have spawned within six weeks.

In the latter part of June I noticed that my spawning and hatching pond of shallow water was very muddy early in the morning. This continued for two or three mornings. I suspected that the 4 remaining fish were there and had commenced spawning, and the draining of the pond June 30 proved their presence. On draining the pond the second time, September 12, I found, in addition to the 4 fish, a "little kettle" of beautiful young carp, ranging in length from 1½ to 2½ inches. There were, however, but 20, the frogs and tadpoles having undoubtedly destroyed spawn, and perhaps some young. Here is at least one instance of scale carp spawning in Tennessee at the age of one year. Besides, the young carp were larger and better fish on September 12 than the original 17 received from the Fish Commission December 22, 1882. If size is a fair index to age, these 4 had undoubtedly spawned before they were 1 year old. In order to investigate more fully, I prepared a small pond 6 by 18 feet in size, with a depth of 14 inches, and placed 12 of the 20 small fry in it. The water is absolutely under control; it is 14 inches deep in the center, and tapers back to an inch in depth. Here I can observe them every day and at any hour. I propose to demonstrate, therefore, that three generations of scale carp can be produced inside of 24 calendar months. The young fish, only 2 inches in length September 12, are now, November 24, from 4 to 5 inches in length.

784. *Statement of J. S. Warren, Jonesboro', Washington Co., Tenn., June 14, 1884.*

GROWTH.—There are many ponds in this vicinity in which carp, placed a year ago last November or December, are now from 22 to 24 inches in length, so I am informed. I have seen no carp, though 2 ponds are less than a mile from me. I have hunted several times in one of the ponds but could not see the fish, which were rendered shy by unruly visitors.

785. *Statement of C. M. Ewing, Dresden, Weakley Co., Tenn., Sept.* 11, 1883.

DISPOSITION OF CARP RECEIVED.—In 1881 I received 3 carp, the remainder of the shipment having died on the way. By some mistake they had laid over at Nashville, Tenn. I gave the 3 to Mr. John W. Jeter, who put them in his pond. This summer the pond overflowed and washed out one of the fish, which his boy found, brought home, and put into a tub of cold well water, but it subsequently died.

GROWTH.—On examination, it was found to weigh about 4 pounds and to contain a considerable quantity of well-developed eggs.

EDIBLE QUALITIES.—It was eaten and pronounced by him a very palatable fish. He said that he would have preferred losing the finest swine on his place.

786. *Statement of John McGavock, Franklin, Williamson Co., Tenn., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 14 carp received in 1880 I placed in a pond covering about an acre, with a depth of from 3 to 4½ feet, and a black, muddy bottom. A bold spring of moderately cool water supplies it.

PLANTS AND ENEMIES.—Plants indigenous here grow in the pond. Frogs inhabit it.

FOOD.—I give the carp corn-bread and green clover once or twice a week.

GROWTH.—The 14 original carp average about ½ pound. I have seen no young yet.

MISCELLANEOUS.—I am constructing a larger pond, and desire some scale carp.

787. *Statement of Thomas R. Falloss, Rock Hill, Williamson Co., Tenn., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received in November, 1880, I put in a ½-acre pond, having a maximum depth of 5 feet and a muddy bottom. At this date the water is quite warm, and about 5 barrels flow through the pond per day, while in spring the flow is 50 barrels. I put brush in the pond for the carp to spawn on. It contains no plants.

ENEMIES.—Bull-frogs inhabit the pond.

FOOD.—I give the carp bread and Irish potatoes daily. They became very gentle in 1882, and when we fed them could be dipped out of the water.

GROWTH.—The 4 original leather carp remaining average 26 inches in length, and weigh about 7 pounds.

REPRODUCTION.—There are about 1,000 young in the pond, which weigh all the way up to 2½ pounds. They first spawned in the spring of 1882.

DISPOSITION OF YOUNG.—I have given some of the young to my neighbors.

DIFFICULTIES.—I had to move the old carp to a smaller pond to prevent the eggs being devoured by the young carp.

788. *Statement of P. Peyton Carver, Mount Juliet, Wilson Co., Tenn., Aug.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—The 10 carp received on November 26, 1880, and the 2 lots of 17 each received subsequently I kept for 2 years in a pond covering 12 square feet, with a depth of 12 inches and a muddy bottom. I then removed them to a ½-acre pond having a depth of from 1 to 6 feet. A stream of from 4 to 6 inches from 2 cold freestone springs situated, respectively, 100 and 200 yards from the pond supplies it with water.

PLANTS AND ENEMIES.—Plants indigenous here grow in the pond. During the first 2 years the small pond was inhabited by bull-frogs. Trout and bream got into the pond this year during an overflow.

FOOD.—I give the carp corn and worms.

GROWTH.—The 3 original carp remaining average from 3 to 4 pounds. The second lot, which I suppose to be leather carp, only weigh from ½ to ¾ pound. The third lot are as large as the second.

REPRODUCTION.—The carp did not spawn while in the small pond. But there are many young in the large pond. The other day I caught at one dip with a net 8 by 12 inches 9 young, each weighing ¼ pound.

DIFFICULTIES.—As the 2 ponds lie near and adjacent to one another, it is difficult to prevent other fish from getting into the carp pond.

TEXAS.

789. *Statement of L. M. Hitchcock, Palestine, Anderson Co., Tex., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 19 carp in January, 1881, and put them in a small pond from 1 to 5 feet deep with muddy bottom. There is a small flow of spring water tinctured with iron and sulphur. There are no plants in it.

ENEMIES.—It contains small perch, and turtles sometimes get in.

FOOD.—I give them corn-meal and sometimes crackers.

GROWTH AND REPRODUCTION.—I do not know how large the old ones are, but they are of good size. The water is muddy. I cannot say how many young there are, but quite a number.

DIFFICULTIES.—There has been no trouble except from snakes and turtles.

790. *Statement of Hon. J. P. Fowler, Bastrop C. H., Bastrop Co., Tex., Sept.* 6, 1883.

GROWTH.—Carp sent to this county by you have made a rapid growth and done well beyond all expectation, though so far as I am informed none have yet commenced to breed.

791. *Statement of Wm. H. Coulson, sr., McDade, Bastrop Co., Tex., July* 15, 1882.

GROWTH.—The 18 carp received January 17, 1882, 5 months since, were then from 3 to 4 inches long. To-day I measured one and found it 17 inches long. They are the wonder of this county. They are in a tank, and I call them up with a little brass bell every day and feed them.

792. *Statement of James Boyd, Belton, Bell Co., Tex., Feb.* 6, 1882.

GROWTH.—I received 20 carp on January 31, 1881, and placed them in a pond 12 miles from this place. They now average about 18 inches in length.

793. *Statement of I. N. Lerich, San Antonio, Bexar Co., Tex., Jan.* 13, 1882.

GROWTH.—The carp, measuring from 2 to 4 inches in length when received on June 29, 1881, now average from 12 to 13 inches and weigh from $1\frac{1}{2}$ to 2 pounds each. The water, food, and climate of this country seem especially adapted to the rapid development of the carp.

794. *Statement of R. K. Chatham, Bryan, Brazos Co., Tex., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in January, 1881, and have received some since. I have an artificial pond covering $1\frac{1}{2}$ acres, with a depth of from 1 to 6 feet, and muddy bottom. During heavy rains the water flows through it abundantly. It contains no plants.

ENEMIES.—It contains perch, but no frogs nor turtles.

FOOD.—We have given them wheat and corn-bread, and sometimes cabbage and lettuce, but we have not fed them regularly.

GROWTH.—I think I have them all and that they will weigh 12 pounds each. They are about 24 inches in length.

REPRODUCTION.—I do not know how many young there are, but they are from 15 inches in length down.

MISCELLANEOUS.—I have scarcely given them any attention at all.

795. *Statement of J. S. Towlkes, Bryan, Brazos Co., Tex., Aug.* 9, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp about 2 years ago and put them in a tank 50 by 200 feet, with a sandy bottom. It is supplied with about 5 inches of rainfall and contains native grasses.

ENEMIES.—It contains catfish and perch.

FOOD.—I give them bran and refuse grain occasionally.

GROWTH.—The few seen seem to be about from 15 to 20 inches in length.

DIFFICULTIES.—I think the catfish have done the more serious injury. Carp seem to do well in all new tanks.

796. *Statement of L. J. Storey, Lockhart, Caldwell Co., Tex., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in January, 1881, and 20 more in January, 1882. In January, 1883, I received 14 for another pond. The pond number 1 has from 2 to 6 feet of water, muddy bottom, and covers an acre. Number 2 has from 1 to 4 feet of water, muddy bottom, and covers a $\frac{1}{4}$ acre. Both are fed by springs, the temperature of which at the inlet is 74°. The pond number 2, situated 100 yards from the spring, is 82°.

PLANTS.—The ponds contain water-cress, of which the carp are very fond.

ENEMIES.—In pond number 1 there are surface minnows and some large frogs, while in number 2 there are frogs, a few small turtles, but no minnows.

FOOD.—Once a day we give them mush made of shorts mixed with corn-meal, and also scraps from the table.

GROWTH.—The old ones are 24 inches long, large and beautiful. I suppose there are 30 or 35 of them in pond number 1. Those sent in January, 1883, are now from 8 to 12 inches long. These, with 5 of the old ones, are in pond number 2.

REPRODUCTION.—In pond number 2 there are thousands of young. This year's young hatched out about the middle of June, and are now from 1 to 3 inches long, while some are as broad as two fingers. I think the minnows ate up the spawn in pond number 1.

MISCELLANEOUS.—I have become very much interested in them, and want to make it a success. I will draw off the first pond this summer, and try to get rid of the minnows.

797. *Statement of Eldridge C. Dickinson, Rusk, Cherokee Co., Tex., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in February, 1880, and 20 more through our State commission. My pond covers $\frac{3}{4}$ of an acre, and averages 2 feet in depth, and has a black, muddy bottom. It is fed by a spring near by with an abundance of water, and is quite cold.

PLANTS.—It contains several grasses, and a kind of flag somewhat like cat-tail, with large and numerous roots.

ENEMIES.—The pond contains perch, minnows, frogs, and turtles. I drained the pond in 1880 and destroyed all kinds of native fish, so as to make way for the carp. In 6 months the water was alive with young perch and minnows In May, 1883, I drained it again and found perch, minnows, turtles, frogs, and craw-fish in quantities. Some of the perch will weigh nearly a pound. Having no connection with other streams, I do not know how they got in. I kill the turtles with a gun, and manage to keep them pretty well exterminated.

FOOD.—I give them shelled corn and corn-meal once in a week or two.

GROWTH.—When I drained the pond this spring, in May, I found all of the old ones. They were 15 inches long and from $2\frac{1}{2}$ to $3\frac{1}{2}$ pounds in weight.

REPRODUCTION.—They have produced no young yet. In May of this year I examined the spawn in as many as a dozen. It was in a large mass of white or yellowish substance, the eggs not being fully defined. I thought from its appearance that it would mature some time during July or August and produce large quantities of young fish, if the native fish do not devour the spawn.

MISCELLANEOUS.—The most serious difficulty has been to keep the minnows, perch, frogs, and turtles out. I am building a new 2-acre pond, favorably located, with muddy bottom and an abundant supply of water. It is isolated, and it will have nothing in it but the carp to start with; so that I can fully test the possibility of keeping it clear of other fish and turtles.

798. *Statement of G. White, McKinney, Collin Co., Tex., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in December, 1879, and put them in an artificial pond 200 yards long, 50 yards wide, and from 2 to 8 feet deep. For 6 months it is fed by a continuous stream of water, but during 6 months receives no water.

PLANTS AND ENEMIES.—It contains moss, flags, and some grasses, and also catfish, perch, turtles, and frogs. The catfish, perch, and turtles, which could not be kept out, destroyed the young one season.

DIFFICULTIES.—We have no constant-running streams for refilling ponds when they have been drawn off. In our heavy floods it is almost impossible to keep the carp from being washed out. During the flood in September, 1880, I lost them all. Thirteen of them were caught on the shoals below, which weighed from $2\frac{1}{2}$ to 3 pounds each. We cooked and ate 2 of them, which were of good quality.

799. *Statement of Max Albrecht Konz, Weimar, Colorado Co., Tex., Apr.* 7, 1882, *in behalf of Joachim Mernitz, Middle Creek, Fayette Co., Tex.*

GROWTH.—The carp received in December, 1881, are now each 18 inches long, and are in a very fine condition. They spawned on March 10, 1882.

800. *Statement of Eugene Potthart, Weimar, Colorado Co., Tex., Aug.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in December, 1880. My pond covers an acre, is not over 7 feet deep, and has a bottom of yellow loam. It is supplied with rain water, the temperature of which sometimes reaches 90°.

PLANTS AND ENEMIES.—There are no plants except the common water-grasses, and no fish, frogs, or turtles in it.

FOOD.—We feed them with old flour-bread and some corn.

GROWTH.—There are 5 of the original lot left, which would weigh between 6 and 7 pounds each. Some of those which died weighed 3¼ pounds on the 17th of August, 1881, when I had had them but 7 months.

REPRODUCTION.—The young from last year's spawning are from 18 to 20 inches long and from 2½ to 3 pounds in weight. The young of this spring are about 4 to 5 inches long.

DIFFICULTIES.—I lost 15 during the first year, which died in the pond. The worst difficulty is the negroes with their hooks and lines.

801. *Statement of George C. Manner, Dallas, Dallas Co., Tex., July* 19, 1882.

DISPOSITION OF CARP RECEIVED.—I received 20 scale and 20 leather carp in January, 1882, which were from 3 to 4 inches in length, the leather carp being the larger. I placed the scale and leather carp in separate ponds.

ENEMIES.—I took out of the pond all the little minnows I could find, and especially hundreds of craw-fish, which I feared would devour the carp.

FOOD.—The carp are now fed daily, and have lost their timidity to such an extent as to come to the feeding-spot by the dozen, and even to eat out of my hand.

GROWTH.—No trace of the carp was seen, except a change in the appearance of the water, it always being muddy, until June 15, 1882, when I caught a carp more than a foot in length. At this I was amazed, as I did not think they were longer than 8 inches. They are from 12 to 18 inches long. There are no young yet.

HOW TO CATCH CARP.—It had been reported to me during the month of May and the first of June that fish had been seen jumping out of the water in my pond. To satisfy myself of the truth of this report, on June 14 I threw into the pond a hook baited with boiled potatoes. As the bait was always eaten off I suspected craw-fish. On the next day, June 15, I used a worm as bait, and within a minute after dropping the hook in the water I caught a carp more than a foot long. The carp was hooked in the side of the jaw, and after carefully removing it I replaced the fish in the water.

HABITS.—A few days ago I saw a leather carp from 17 to 18 inches long, with two-thirds of its body out of the shallow water, rooting in the mud for the distance of from 8 to 10 yards. It then turned into deeper water, where it continued the same operation, reminding me of the rooting of a hog.

802. *Statement of Jas. C. Michener, Hutchins, Dallas Co., Tex., Sept.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I lost about half of the first lot of carp bringing them from Austin in cans, but I received some more last February. I have an artificial pond at the head of a spring, which is from 2 to 4 feet deep.

PLANTS AND ENEMIES.—It contains duck-meat and English water-cress, and also small catfish and sunfish.

FOOD.—I gave them corn-mush and corn-bread daily at first, but only rarely since the grass and weeds have grown.

GROWTH.—They are at present about a foot long.

803. *Statement of W. A. Kendall, Pilot Point, Denton Co., Tex., Jan.* 10, 1882.

GROWTH.—On April 1, 1881, I placed in my pond 18 carp from 2 to 4 inches long. I drained the pond on August 1, 1881, to rid it of the catfish that were in the pond before I placed the carp there, and found only 7 of the original number. But each one was 14 inches long; and as soon as this fact became known others at once commenced preparations for their culture. I will be able to report in another year that this new industry is a grand success in Northern Texas.

804. *Statement of E. N. Gray, San Diego, Duval Co., Tex., Oct.* 27, 1882.

GROWTH.—I have 3 tanks, in one of which there is a carp 16 inches long, weighing 3½ pounds. It is the only one I have left of 13 received last January.

ENEMIES.—I had a lot of geese and ducks in the tank where I put the carp and I suppose they ate up all the rest, as the carp were very small, being only 2 inches long.

805. *Statement of J. B. Chalmers, Ennis, Ellis Co., Tex., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 23 carp about 4 years ago, and 24 more about a year ago. I have kept them in 2 ponds containing 1 acre and 1½ acres, respectively. These tanks are fed by rain water and are screened.

PLANTS AND ENEMIES.—They contain some lilies, and also catfish, perch, and frogs innumerable.

FOOD.—I have never fed them. They appear to do well without much care.

GROWTH.—I think the oldest will weigh 20 pounds.

REPRODUCTION.—The tanks appear to be full of young from 3 to 4 inches long.

MISCELLANEOUS.—I am satisfied they are the fish for this country. I believe salmon and trout would also do well, and intend trying them in another tank.

806. *Statement of Arthur O'Keefe, Honey Grove, Fannin Co., Tex., June*, 1880.

FOOD.—My carp are quite gentle, seeming to care little for the appearance of man, and even coming slyly up to nibble at a biscuit held in the hand. A few blasts of a tin horn and the scattering of a handful of bread on the water bring them by hundreds to its surface, when they eagerly seize their food.

GROWTH.—Most of the carp are about 5 inches in length, though there are many both larger and smaller in the lake, which was first stocked with 70 carp last year.

807. *Statement of Samuel Johnson, Savoy, Fannin Co., Tex., Apr.* 24, 1882.

DISPOSITION OF CARP RECEIVED.—The carp received on January 10, 1882, I placed in a body of water that is capable of sustaining thousands.

FOOD.—I gave the carp biscuit, meal, salad, bread, refuse from the table, and worms. They are perfectly gentle and come to the feeding place at the rattle of a sheep-bell. I feed them every day as I do chickens.

GROWTH.—The smallest carp that I received was 1½ inches long and has now attained a length of 4 inches, while some of them measure 8 inches. They grow like pigs when given a plenty of buttermilk. I can make them average from 5 to 6 pounds by summer if I feed them well.

808. *Statement of G. Hillje, Schulenburg, Fayette Co., Tex., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in December, 1880. My pond covers 1½ acres, is 9 feet deep in the deepest place, and has a bottom of loam and mud. There is no water flowing through it except when a heavy rain causes it to overflow. Its temperature is 90° at dinner-time.

PLANTS.—It contains *Nymphæa odorata*, *Acorus calamus*, *Typha latifolia*, *Phragmites communis*, and some others.

ENEMIES.—There are perch, craw-fish, frogs, and turtles in it.

FOOD.—I fed them every morning and evening with bread and Irish potatoes; sometimes with watermelons and pumpkins.

GROWTH.—I have 17 of the original lot. In December, 1882, the largest one measured 24 inches and weighed 11 pounds. The smallest one measured 14 inches and weighed 5 pounds.

REPRODUCTION.—They had produced 176 young up to December, 1882. These young are now about 10 to 12 inches long. They have not spawned this season. I left half of the young with the original lot and put half in another pond.

DIFFICULTIES.—In 1881 my pond dried up, and I had to keep them in a box 2 months. As there are no springs it is sometimes difficult to keep the pond full of water. We are now having a dry summer, and I think I will have to buy a hydraulic ram to lift water out of the creek into the ponds.

809. *Statement of Christopher Steinmann, Swiss Alp, Fayette Co., Tex., Oct.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in December, 1880, and have received 14 since. I kept them in a pond of about ½ an acre, averaging 4 feet in depth and with a black, muddy bottom. The pond contains a spring, so that there is water flowing out of it all the time, and it is quite cold.

PLANTS.—It contains all kinds of grasses. One grows to the height of 4 feet, and has very thick, fleshy roots.

ENEMIES.—There are minnows and bull-frogs, but no turtles in it.
FOOD.—I give them boiled corn and bread twice a week.
GROWTH.—The 11 that remain will weigh from 8 to 10 pounds each. They have not produced any young yet.

810. *Statement of P. Haschke, Winchester, Fayette Co., Tex., Sept.* 10, 1883.

DIPOSITION OF CARP RECEIVED.—Of the carp which were sent to me only 8 arrived alive. Five of them are still doing well. I kept them in a tank. This season has been very unfavorable, the driest for 22 years.
ENEMIES.—I find a great many minnows in my tank, and do not know whether they are carp, perch, or catfish, though I have caught a full-grown perch and a full-grown catfish.
GROWTH.—My carp have grown and done well, the largest measuring 17¾ inches in length and 14½ inches in belt.

811. *Statement of M. S. Finch, sr., Wortham, Freestone Co., Tex., Aug.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—I received 19 carp in December, 1880, and put them in a tank covering 3 or 4 acres, with a depth of from 2 to 12 feet, and a muddy bottom. It never overflows except when we have heavy rains. It gets quite warm in the summer.
PLANTS.—It contains Bermuda grass.
ENEMIES.—The pond contains craw-fish, which I have about made up my mind are catching the carp, and so I am catching the craw-fish. There are a few turtles.
FOOD.—I have given them corn and scraps of bread from the table, but not regularly.
GROWTH.—Last year they weighed from 5½ to 7½ pounds. I suppose they will weigh at least 10 pounds now.
REPRODUCTION.—In April, 1882, there was a large school of young, which are now 12 to 15 inches long. There are too many of them, and I have been catching them to eat and to give away to stock other tanks. I gave away hundreds of them in 1882, and this year I have stocked other tanks and sold about 500.
EDIBLE QUALITIES.—I commenced eating carp in 1882, and have been eating them ever since. We fry them, and they are very good.
MISCELLANEOUS.—The whole secret of my success is that I had a new tank and no other fish could get in to destroy the eggs.

812. *Statement of J. P. Lee, Wortham, Freestone Co., Tex., Aug.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—I received 19 carp in December, 1880, and put them in a pond covering an acre with a depth of 4 feet and a bottom of clay and sediment. No water flows through it, and it contains no plants.
ENEMIES.—There are catfish, white perch, frogs, and snapping-turtles in it.
GROWTH.—The year after they were put in 3 were seen, which were then 15 inches long. I have not fed them and have seen no young.
MISCELLANEOUS.—They do well in this country when in new tanks by themselves, and poorly when put with other fish.

813. *Statement of Thomas Longbotham, Wortham, Freestone Co., Tex., Aug.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in the fall of 1880. My pond is from 2 to 8 feet deep, covers 2 acres, and has a sandy bottom.
ENEMIES.—There are perch, catfish, frogs, and turtles also in the tank.
GROWTH.—They weigh at present about 8 pounds each.
MISCELLANEOUS.—I have not fed them, because there were other fish in the tank, but do not know how many there are. I have never seen any young, and if there were any the other fish probably destroyed them. I have built a new tank expressly for carp, and would like to have some more.

814. *Statement of A. N. Snapp, Wortham, Freestone Co., Tex., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp about 3 years ago, and, having no suitable tank, put them in a small tank, which soon dried and the carp died. The carp which our neighbors got at the same time have done well. I have now made 3 tanks, from 1 to 3 acres each, and from 10 to 15 feet deep, for carp.

815. *Statement of S. A. Cook, Denison, Grayson Co., Tex., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 12 carp, 3 or 4 years ago, and have kept them in a pond 20 by 600 feet, 6 feet deep, with a muddy bottom. It is supplied with the rain-water drawn from about 40 acres.

PLANTS.—It contains Bermuda grass and weeds.

ENEMIES.—It contains catfish and perch. I fear the other fish have destroyed my carp; the catfish weigh about 5 pounds now.

816. *Statement of J. V. Cockrell, Sherman, Grayson Co., Tex., Oct.* 21, 1882.

GROWTH.—We have just weighed some of the carp received February 12, 1882, and find them ranging from 2 pounds to 4 pounds and 7 ounces. Mr. James H. Dunn weighed one October 12, 1882, which turned the scales at 4 pounds and 7 ounces, the largest one yet weighed, though several have weighed 4 pounds. This seems almost incredible, but these weights are verified by our best citizens. I frequently visit the pond of Mr. Wallace, near this place, who received 21 carp in November, 1880. The fish feed in very shallow water, hence I was able to estimate their true weight. The smallest carp weighs 2 and the largest 4 pounds. An offer of $10 apiece has been made for 2 or 3 of these fish, but refused. It is expected that they will spawn this spring.

MISCELLANEOUS.—All these fish, or quite a number of them, will spawn next spring, which will insure an abundance of fry for next year. Nearly all of our small streams go dry in July and August, which has made it necessary for almost every farmer to make a pond of water for his stock, and it is in these small ponds, covering from ½ acre to 10 acres, that these fish grow so well and seem to be so much at home. The high temperature of our waters during the summer months seems peculiarly adapted to their growth and development. They will add much to the food supply of Texas.

817. *Statement of M. S. Klum, Sherman, Grayson Co., Tex., July* 31, 1883.

DISPOSITION OF CARP RECEIVED.—Five of the carp sent me in May, 1881, reached me alive, and I received some more in February, 1882. My pond covers about an acre, and is from 1 inch to 5 feet deep. It is fed entirely by surface water, but occasionally I let in some from another pond to make up for evaporation. It is exposed to the sun, and gets very warm.

PLANTS.—I put some plants in the water about a month ago, and they disappeared in a few days.

ENEMIES.—The pond contains a few sun-perch and catfish. Bull-frogs, turtles, &c. are plenty. There is occasionally a bass. The ducks have been the worst enemy that I have known; but no doubt the turtles, frogs, cranes, &c. destroy many fish.

FOOD.—I have given them no food, but they have done well on what they could find.

GROWTH.—When I drained my pond in February, 1882, I found 3 of the original lot, which were about 16 to 18 inches in length. They had grown 15 inches in about 10 months. My fish have grown faster than any fish I have ever seen. Some of my neighbors have carp that have not grown like mine, their springs and wells being impregnated with minerals to such an extent that catfish and perch will only live one or two day in the water.

REPRODUCTION.—I watched continually during the summer of 1882 for young carp, but I could find only young perch. But in January, 1883, I drained the pond again and I found the 3 old ones and 1,500 young carp. They were from 4 to 9 inches long. I have never seen one as small as those I first received, which were only 1½ inches long. I refilled the pond and turned them loose again. I have not seen a single young carp this summer, though I find plenty of young perch near the edge of the water. When I drained my pond in the winter I threw out all the native fish.

SALES.—I have sold a few at 10 cents apiece and given some to my friends. I have never eaten any, preferring to give or sell them to those who want carp.

818. *Statement of Mrs. M. A. Wallace, Sherman, Grayson Co., Tex., Sept.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—I received 21 carp in December, 1880. The pond in which I put them covers ½ an acre, is about 4 feet deep, and has a clayey and sandy bottom. The water is at a temperature of 91 degrees to-day.

ENEMIES.—There are no plants nor other fish than carp in it. There are some frogs and turtles, of which I have killed 3.

FOOD.—I feed them every day with corn-bread, and sometimes with corn and lettuce.

GROWTH.—I still have 15 of the original lot, and think they would weigh from 8 to 10 pounds each. They are about 30 inches long.

REPRODUCTION.—They have produced a good number of young. The young are now of all sizes, the size of your finger up to the length of your hand.

SALES.—I have sold some to supply other ponds. My only difficulty has been to catch them.

819. *Statement of A. H. Wilkins, Whitesborough, Grayson Co., Tex., July* 21, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in January, 1881, and put them in a pond 4 by 10 feet, and 3 feet deep. In April last I changed them to a pond of spring water covering ½ an acre, 8 feet deep, and with a muddy bottom.

PLANTS AND ENEMIES.—It contains flag, or cat-tail. There are top swimmers, frogs, and turtles in the pond.

FOOD.—I give them bread 3 times a week.

GROWTH.—The 9 that I have left would weigh from 4 to 6 pounds each.

REPRODUCTION.—They produced no young last year, but at this time the young are innumerable and are from 1 to 2 inches in length.

DIFFICULTIES.—The most serious difficulty has been with the turtles.

820. *Statement of S. P. Morgan, Gladewater, Gregg Co., Tex., June* 12, 1882.

GROWTH.—I placed the carp received on January 11, 1882, in my pond on the following day. I caught one on June 7, 1882, and to my surprise it measured 11 inches in length and weighed a pound. The carp were only from 2 to 5 inches long when received, and this great growth was attained in this short while without any artificial food. The carp is one of the finest fish we have.

821. *Statement of C. C. Gibbs, Houston, Harris Co., Tex., Sept.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—The carp which I received I put in a tank located in a mountainous country, where there are very heavy rains at times. The serious freshets of last year I think overflowed my tank to such an extent as to carry the carp all away.

822. *Statement of W. J. Hutchins, Houston, Harris Co., Tex., May* 12, 1883.

DISPOSITION OF CARP RECEIVED.—In January, 1882, I received 20 young carp from 2 to 3 inches long, and placed them in an artificial pond dug in my garden, 15 by 25 feet, and about 5 feet deep. The pond is kept full with water from the water-works.

FOOD.—The fish were fed regularly with wheat-bread and bran, with some rice and corn-bread, also lettuce, mustard, cabbage-leaves, &c.

GROWTH.—They appeared to grow very well, and in November some of them were nearly or quite 12 inches long. I have now a full supply of young carp.

823. *Statement of W. H. Carter, Marshall, Harrison Co., Tex., Mar.* 22, 1884.

GROWTH.—I took from my pond to-day 3 carp 20 inches long. I planted 20 minnows January 7, 1882.

824. *Statement of Mrs. S. A. Teel, Kyle, Hayes Co., Tex., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 18 carp in December, 1880, and 17 January 17, 1882. My pond is 5 feet deep, 60 by 50 feet in dimension, and has a bottom of black dirt. It is supplied with about 50 barrels of spring water per day, which is moderately cool.

PLANTS AND ENEMIES.—It contains water-cress and native grass. There are also turtles, craw-fish, frogs, and minnows in the pond.

FOOD.—This consists of corn-bread, biscuits, and vegetables.

GROWTH AND REPRODUCTION.—I think I have about 14 of the original lot which would weigh from 6 to 8 pounds each. They have produced a great many young, which are of all sizes and weights.

DIFFICULTIES.—They may have been preyed upon by turtles, but I expect the pond to pay me well.

825. *Statement of R. C. Spinks, Crockett, Houston Co., Tex., July* 13, 1882.

GROWTH.—The carp received in January were placed in my pond on the 25th of that month. I have just drained my pond and find them to measure 12 and 13 inches. I have only lost 2.

FOOD.—They are very fond of Bermuda grass, and have lived on that alone, as I have fed them none at all.

826. *Statement of S. S. Walker, Groesbeck, Limestone Co., Tex., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp which I received in 1881 I put in the tank of Mr. J. A. Gardiner, near Mexia, and have since learned that they are doing well and increasing very fast.

827. *Statement of Oscar Wiley, Groesbeck, Limestone Co., Tex., Feb.* 9, 1883.

GROWTH AND REPRODUCTION.—The carp are doing well and multiplying rapidly. I have them in great quantities and am much pleased with them. They grow so fast I think I shall be able to commence using them this spring.

828. *Statement of Volney Metcalfe, Kosse, Limestone Co., Tex., June* 28, 1880.

DISPOSITION OF CARP RECEIVED.—The carp received in the fall of 1879 I put in a well having 4 feet of water in it. I connected the well with a tank by means of a small ditch, in order to fill the well with water, and left the ditch open so that the water would not stagnate. I put 5 of the carp in the tank.

FOOD.—I feed the carp on corn-bread and vegetables, such as tomatoes, squash, &c., all of which they eat. They seem to like the squash best, preferring it baked. Corn-bread is their favorite diet, and by feeding them at the same place every day they become accustomed to look for it. All we have to do when we wish to see them is to tie a piece of stale bread to a string and float it on the water, when they come up all around it, and scramble for it like hogs for corn.

GROWTH.—The carp remaining are now 4 inches wide and a foot long.

DIFFICULTIES.—Several of the carp appeared to be sick when received, and died soon afterwards.

829. *Statement of H. M. Munger, Mexia, Limestone Co., Tex., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp about 3 years ago and put them in a tank 10 feet deep, with a clayey bottom. It is supplied with drainage water from 200 acres of land. It contains several kinds of plants.

ENEMIES.—It contains perch and catfish.

GROWTH.—I caught a carp about 27 inces long.

MISCELLANEOUS.—As the pond is on my ranch, 16 miles away, I have never fed them, and can't say how many remain or whether they have produced any young.

830. *Statement of J. M. Waller, Mexia, Limestone Co., Tex., Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in December, 1881. My tank covers 3 acres of land, is from 1 to 12 feet deep, and has a bottom of very soft mud.

ENEMIES.—Catfish, perch, and some turtles are in the pond.

GROWTH.—The old ones are now about 2 feet long.

REPRODUCTION.—They have produced a good crop of young, which are from 8 to 12 inches in length.

DIFFICULTIES.—The most serious difficulty has been to catch them. They are very likely to follow high water over the waste-way and escape. We have found them on the prairie below after a freshet.

831. *Statement of A. P. Brown, M. D., Jefferson, Marion Co., Tex., Aug.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—I received 75 carp in 1879 and have received more since that time. My pond is 30 by 75 feet, 1 to 6 feet deep, and has a muddy bottom. It is supplied with the rain water which falls on 20,000 square feet of roofing.

PLANTS.—It contains Bermuda and crab grass, and the ponds of my neighbors contain Bermuda, crowfoot, crab, and common water-grasses.

ENEMIES.—There are no enemies in the pond.

FOOD.—I give them bread, and sweepings from freight cars, such as corn, oats, &c. The fish, when regularly fed, are very gentle and follow their feeders all around the pond.

GROWTH.—I have 5 or 6 of the original lot, which are about 23 inches long and weigh from $4\frac{1}{2}$ to $5\frac{1}{2}$ pounds each.

MISCELLANEOUS.—I believe carp to be a success in all waters of this section not impregnated with iron, copper, or sulphur. Most of the parties to whom I have delivered

carp report very satisfactory results, especially those who have given the fish one-half of the attention they deserve. Some of the ponds where the fish grow rapidly have no young. In other ponds they have multiplied rapidly, while in still others there is no increase of young, but a loss of some of the old ones.

832. *Statement of B. C. Hinnant, Daingerfield, Morris Co., Tex., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 50 carp in the fall of 1879. My pond covers $1\frac{1}{2}$ acres, is from 2 to 16 feet deep, and has a muddy bottom, and is fed by springs. There is but little water overflowing. In the summer months the water gets very warm on top, but is cold at the bottom.

PLANTS.—It contains pond-lilies that have a broad leaf, but no grasses.

ENEMIES.—It contains perch and frogs. I try to keep the frogs out.

FOOD.—I give them corn-bread once or twice a week.

GROWTH.—I suppose the old ones might weigh about 4 pounds each.

REPRODUCTION.—I had a large lot of young carp last summer. I have several thousand of them still for sale, that are from 5 to 10 inches long, and will spawn next spring. I have given away some and sold several hundred at a very small price. The ones that hatched this year are now from 1 to 3 inches long.

DIFFICULTIES.—The greatest difficulty has been to keep the snakes and frogs out.

833. *Statement of G. A. Vinn, Corsicana, Navarro Co., Tex., Aug.* 25, 1882.

DISPOSITION OF CARP RECEIVED.—The carp received on January 16, 1882, I put in a tank, and saw no more of them till late in May. My tank overflowed, and I found they had gone. I put a screen across the waste-way. About 20 days ago we had a very heavy rain and part of the dam gave way. I found one carp 12 inches long lodged against the screen. Last night there was another lodged against the screen, measuring 14 inches. I would not take $5 apiece for what remains if I could get no more. I cannot raise meat half so cheap.

834. *Statement of L. T. Wheeler, Corsicana, Navarro Co., Tex., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp January 10, 1881, and have since received from different sources 80. My pond covers an acre, and has a depth of from 6 to 20 feet, and a muddy bottom. It is supplied with rain water only. This is discharged by a sluice, and protected with wire screen. The water gets quite hot in summer. I am now constructing large ponds to raise carp for market. We make our ponds by solid dirt embankments across ravines. They are simple in construction and furnish an ample supply of water. Many ponds contain from 5 to 10 acres.

ENEMIES.—I am troubled only with frogs and sun-perch. It is almost impossible to construct a pond that will keep them out.

FOOD.—From March to November I feed them twice a day on bread, vegetables, wheat, barley, millet seed, &c.

GROWTH.—The oldest, of which I have lost none, are more than 3 feet long, and weigh from 20 to 25 pounds each. In this climate they weigh from 6 to 8 pounds when one year old.

REPRODUCTION.—It is impossible to tell how many young there are, they are so numerous. They are of all sizes. They begin spawning about May 10, and continue to spawn till November 1. They spawn in shallow water, and I am preparing a special pond with shallow water for propagation.

SALES.—Carp are worth from $12\frac{1}{2}$ to 15 cents a pound here in the market, and there is a very large and increasing demand. I can sell $300 to $500 worth next spring. It is better than market gardening, as it is all profit. I have succeeded beyond my most sanguine expectations.

835. *Statement of L. T. Wheeler, Corsciana, Navarro Co., Tex., July* 1, 1884.

PONDS AND ENEMIES.—I have now had $3\frac{1}{2}$ years' experience in the raising and hatching of German carp, and it may be that my experiments may be worth something to others, particularly in the South. All still-water ponds should be as deep as possible so as to prevent stagnation and to insure a certain supply of water when the rainfall is alone to be depended upon. As it is next to impossible to keep out native fish, I had to resort to partially artificial means to hatch and protect carp.

REPRODUCTION.—I have adopted the following plan with eminent success:

About the 1st of May, having first procured a quantity of long sea-moss, I tie it in small bunches and lay it in shallow water near the bank, attaching it safely to the bank

where it will have as good an exposure to the sun as possible: carp will not spawn in the shade. By the 5th of May in this latitude (32°) the carp will begin to spawn. They may be seen in great numbers, fluttering near the banks in shallow water, and they will be sure to find the moss and to deposit innumerable eggs upon it: the eggs will adhere to the moss from 3 to 4 days and then drop off. To protect the eggs and the young from the ravages of other fishes I constructed boxes 10 feet long and 5 wide. The gunnels or side pieces are 1 by 12, with a good water-tight bottom. The ends of these boxes are made of wire-cloth sufficiently fine to prevent the escape of the smallest carp and to admit a constant flow of fresh water. The bottoms are covered an inch deep with pure sand. When placed in the water they sink until the water stands from 6 to 8 inches deep in them. As soon as I discover the eggs on the moss, I gather up the moss and lay it in these boxes, putting weight enough on to keep it barely under the water. In 8 or 10 days, according to the temperature of the water, the young will be seen. It is best to anchor these boxes in the middle of the pond, where they will be subjected to the action of the wind and waves and have as fair an exposure to sun as possible. After the young are 2 or 3 weeks old they should be protected from the midday sun. It is wonderful how many can be hatched in a box of the size given. As the growth increases they should be divided and kept until they are large enough to take care of themselves, which will be in 2 or 3 months, if there are game fish in the pond. I commence feeding when a month old by sprinkling corn-meal in the boxes, but not enough to leave a residuum.

Carp do not spawn in this climate until they are 2 years old, and at 3 they spawn enormously. They begin by the 5th of May and run from 3 to 5 days only. I had only one that was as late as the 25th this year. I did not observe it spawning but one day, though I watched it closely day and night. I placed all the spawn of this one in a box by themselves; yesterday I bailed the water out of this box, straining through a wire sieve; it is simply wonderful how many young there are—too many to count.

SALES.—I am now selling the young, having sold to one man 1,000 at $15 per hundred, and have demand for every one that I can hatch.

MISCELLANEOUS.—I have given the cultivation of the carp the closest attention, endeavoring to find out the most simple way to hatch and protect them, and one that any farmer could understand and adopt without requiring much time or attention. I have been eminently successful, and there is no reason why others should not be. My oldest carp are now 3½ years old and I expect to exhibit one at the fair in New Orleans that will weigh 30 pounds.

836. *Statement of Henry Jones, Cross Roads, Navarro Co., Tex., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp 2 years since and put them in a large tank, 15 feet deep, with a muddy bottom, and large enough to float a steamboat. It is supplied by rain water and sometimes overflows. Yesterday with the thermometer at 100° the water temperature was 30°.

PLANTS.—It contains grass.

ENEMIES.—It contains catfish, perch, frogs, turtles, and any amount of snakes.

MISCELLANEOUS.—I have not fed them nor taken any care of them. The tank is so large that it is difficult to see the carp or do anything with them. I have never seen any one of the 20 that we put in 2 years since, and if there are any I do not know it. I have never seen any young and have never caught any.

837. *Statement of W. S. Robinson, Dresden, Navarro Co., Tex., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp December 23, 1880, but lost them all on account of the drouth. I received 38 more January 20, 1882. My tank covers one acre, is from 2 to 8 feet deep, and has a muddy bottom. It is supplied entirely with rain water.

PLANTS.—It is covered with water-lilies called in Texas young pin or water-acorn.

ENEMIES.—Catfish, perch, and bull-frogs have gotten in since I put the carp in

FOOD.—I give them scraps from the kitchen but they do not seem to need much food, because there is vegetation in the water and all around it.

GROWTH.–I should think those received last would measure about 20 inches in length. They have not spawned that I know of.

838. *Statement of Thomas Jackson, Bremond, Robertson Co., Tex., June* 24, 1882.

DISPOSITION OF CARP RECEIVED.—The 18 carp received on January 15, 1882, and which I placed in my pond, were doing well up to the very heavy rain of May 6. This

flooded the country generally, caused my pond to overflow, and allowed most of my carp to escape.

FOOD.—The pond being newly constructed, it afforded a sufficient supply of natural food to sustain them. They are beginning to take food which I place in the pond.

GROWTH.—The few carp remaining are doing remarkably well, their growth being astonishing and their general condition very prosperous. They were only from ½ inch to 2½ inches long when received, but now average from 10 to 14 inches, this remarkable growth having been attained in about 5 months.

839. *Statement of T. C. Moore, Bremond, Robertson Co., Tex., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 19 carp in the winter of 1881, and 5 in the winter of 1882. I have an artificial pond containing about ¼ of an acre and supplied with water by the drainage from higher ground. It is from a few inches to 3 feet deep, and has a muddy bottom.

PLANTS.—It contains wild grass and water-grass and Bermuda grass.

ENEMIES.—There are no other fish, but there are frogs, craw-fish, and perhaps a few turtles in it.

FOOD.—I have fed them with bread, but irregularly on account of the distance of the pond from the house.

GROWTH.—They are now apparently 18 inches long and would perhaps weigh from 6 to 8 pounds each.

DIFFICULTIES.—The most serious difficulty has been to keep the water from overflowing during heavy rains. Nearly all the first lot escaped in this way. Owing to the distance of the pond and the muddiness of the water, I am not able to tell whether there have been any young produced or not. I intend to provide a better pond and to devote more attention to them.

840. *Statement of G. B. Byrd, Cold Springs, San Jacinto Co., Tex., June* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received 12 live carp in February, 1883. After dividing them with Mr. Thomas L. Ross, I immediately placed 6 fish in my pond.

ENEMIES.—I have no other fish in the pond, not even a minnow.

FOOD.—I fed them during the winter on boiled rice, corn-meal, and flour, in about equal parts, baked into cakes of from 1½ to 2 inches in thickness, and corn-bread, pan length. I saw nothing of these fish until May 10, and began to fear that some accident had befallen them, yet I continued to deposit food. I now have them so that they will come to my call and feed right under my feet. They rise to the top of the water and suck in a piece of biscuit as quickly as a hungry dog would devour it.

GROWTH.—On May 10th I saw floundering around in some weeds a carp fully 12 inches long, and since that day I have never failed to see them. There is one in the lot that must certainly be an extra fine specimen of the carp, as it is 16 inches long and large in proportion. When I put them in the pond the largest could not have been more than 4 inches long, and now the smallest is certainly more than 10 inches. In fact, the growth has been so remarkable that one would scarcely believe it.

841. *Statement of G. B. Byrd, Cold Spring, San Jacinto Co., Tex., July* 16, 1883.

FOOD.—I have been experimenting as to the best food for carp. I give them both muskmelons and watermelons, which they eat, but not with relish. They are extremely fond of German millet, broom-corn, and Egyptian wheat in the dough state, or just as it is ripe to cut. During fruit season I purpose feeding some of my carp exclusively on fruit, such as pears, summer apples, plums, and grapes.

GROWTH.—I have seen some carp that were placed in a pond one year before mine; but I think my 6 carp will weigh quite as much, if not more, than those; while I have one that is much larger than any of those alluded to. The Russian gentleman says mine are as large as carp grown in Russia in 3 years, and that he rarely saw carp twice the size of mine in the markets.

842. *Statement of Mrs. Nellie Clark, Fort Worth, Tarrant., Co., Tex., Oct.* 14, 1883.

GROWTH.—One year ago last winter I received 20 carp. A short time ago a net was drawn through the pond, and we found them to be from 10 to 12 inches long. We are greatly in need of aquatic plants.

GROWTH AND REPRODUCTION.—Writing subsequently, under date of October 31, 1884, Mrs. Nellie Clark, Fort Worth, Tarrant County, Texas, says: "On dragging a net

through my pond to find out if it contained catfish, we brought out 2 carp that measured from 18 to 24 inches. The pond is alive with young, and it will be necessary for me to enlarge it for their accommodation."

843. *Statement of L. W. Crawford, Fort Worth, Tarrant Co., Tex., Aug.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—I received 14 live carp in February, 1881. My pond is 100 yards long by 15 wide, 2½ feet deep, and has a muddy bottom. It is fed by a 1-inch stream of water from an artesian well, the temperature of which is from 30° to 60°.

PLANTS.—It contains a long water-grass common in Texas swamps, and water-cress common in all parts of the country.

ENEMIES.—It contains no other fish except some minnows, ¾ of an inch long. There are no frogs nor turtles.

FOOD.—I have given them bread, turnips, lettuce, cabbage, and dough made of one part flour and 3 parts meal. They love lettuce better than any other kind of vegetation. They will eat turnips, mustard, and cabbage when young, also boiled Irish and sweet potatoes. They will eat tender ears of corn very readily. The dough, one part flour and 2 parts meal, is the best food for them.

GROWTH.—The 14 still live and would weigh from 8 to 10 pounds. I never saw anything grow as they do. The first year's growth was about 3 pounds. They were about 2½ inches long when I got them, and at the end of the first year were 12 inches long. They are now from 18 to 20 inches long. They have produced no young yet.

MISCELLANEOUS.—I should like to make carp-growing a business, as this is a good fish market.

844. *Statement of William Brueggerhoff, Austin, Travis Co., Tex., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in July, 1880, and put them in a fountain about 8 or 10 feet in diameter, and 1½ feet deep. The cement bottom has a covering of about 3 inches of slime and mud. There is a continuous flow of water through the fountain.

PLANTS.—It contains ferns of all descriptions, which grow on artificial mounds.

ENEMIES.—It contains perch, green frogs, and minnows, a small fish about ½ an inch in length.

FOOD.—Two or three times a week I feed them with light bread and scalded meal, ⅓ flour and ⅔ corn-meal.

GROWTH.—The 4 that remain weigh about a pound each and are about 10 inches long. We gave away some of them.

REPRODUCTION.—They produced about 100 young. We still have 7, which are from 6 to 8 inches long, and weigh perhaps 4 ounces. The remainder of the young were distributed among our friends to put in public fountains, &c.

DIFFICULTIES.—There have been no difficulties at all in managing them.

845. *Statement of J. H. Dinkins, Texas Fish Com'r, Austin, Travis Co., Tex., Oct.* 4, 1880.

GROWTH AND REPRODUCTION.—A day or two ago I saw one of the carp received last winter (these fish were the young of 1879, and about 3 or 4 inches long when received), which measured 20 inches in length. I am inclined to think they spawned last summer for the reason that the pond is now filled with small fry, unknown before in the pond.

846. *Statement of editor of Texas Farm and Ranch, Austin, Travis Co., Tex., May* 1, 1884.

DISPOSITION OF CARP RECEIVED.—The State fish-ponds at Austin, Tex., are now in a most flourishing condition, and much taste has been displayed in decorating the walks with flowers and shrubs, and other attractive improvements. The ponds are situated close to Barton's Creek (about 2 miles from Austin), from which they are supplied with cold spring water. There are 4 of these ponds, 3 of which are fully stocked with carp of different ages. They are connected with sluices by which they can be dried, and fish may be easily taken or transferred, as required.

FOOD.—At the tap of the bell the finny boarders dart forward to the refectory with a sound like a distant waterfall, and a ripple on the surface of the water like that produced by a heavy driving rain. Scraps of bread and vegetables are then devoured, while the water is flecked with gold and silver from the sides and bellies of the feeding fish. "Do the young fish in the adjoining pond also answer to the bell?" we asked. "Oh, no," was the reply, "it takes about six months' training to educate them up to that point;

but when they have learned the lesson they never refuse to put in an appearance at meal-time."

GROWTH AND REPRODUCTION.—Of all sizes there are at present about $\frac{1}{2}$ a million carp, with facilities for increasing the number as the demand for stocking rivers and private ponds increases. Of all fish it is the best adapted to our climate, both for successful culture and large profit.

EDIBLE QUALITIES.—The quality of its flesh depends upon the character of its food. Carp in running streams or in ponds, where limited to mud or rank weeds for subsistence, are no better than the salt-water mullet; but it has been demonstrated by pisciculturists that when properly fed they are little if any inferior to salmon.

MISCELLANEOUS.—Of the importance of this fish as a factor in the future food supply of Texas, too much cannot be said; and yet it would seem sufficient merely to state that in a pond only a few square rods in area, the farmer can raise, without expense, more carp than is sufficient to supply his family the year round. Indeed, we trust the day is not far off when the carp pond, shaded with big trees and willows, and decorated with rose-bushes and flowers, will be the possession of every farmer who aspires to thrift, taste, and good living.

847. *Statement of John B. Lublock, Austin, Travis Co., Tex., June* 3, 1884.

EDIBLE QUALITIES.—We have tested fully the edible qualities of the German carp, and all pronounce it a first-class fish and reasonably clear of bones.

848. *Statement of William Radam, Austin, Travis Co., Tex., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp in 1882, and 20 more July 1, 1883. The first lot were kept for a year in a well, 10 by 10 and 5 feet deep. The water was cold and they did not grow much. In January last I transferred them to a pond 50 by 100 feet and 6 feet deep, with a bottom of black loam, very muddy. It is supplied with irrigating water from the garden, and is always full. The water is warm on top. I am going to make a pond 400 feet long and 100 feet broad, as I have plenty of water. I am pumping, in dry weather, 750,000 gallons per day.

PLANTS.—It contains caladium esculentum, grass, and willows, but not large enough for shade.

ENEMIES.—There are no other fish, but there are a few frogs and some craw-fish in it.

FOOD.—Once a week I throw in cabbage, lettuce, scraps, &c. In addition we give them a little bread in the evening, when we call them with a bell.

GROWTH.—While they were in the well they only grew to be from 4 to 6 inches long. About January, 1883, I transferred the 13 old ones to the pond, and they are now from 8 to 12 inches long. In 7 months they have grown at least twice as large, and to be 4 times as heavy. I have seen in Germany all sizes of carp up to 40 or 60 pounds, but find that carp grow here in Texas at least twice as fast as in Europe.

MISCELLANEOUS.—I bought a good lot of water-plants and put them in the pond, but the carp killed them entirely by eating off the tops. The little carp I received this summer we put in the pond with the others. I am going to make a pond 400 by 100 feet, and make carp-raising and selling a business.

849. *Statement of J. B. Rogers, Duval, Travis Co., Tex., Dec.* 10, 1880.

GROWTH.—One of the carp, 4 inches long, received 11 months ago has reached the astonishing length of $20\frac{1}{2}$ inches and weighs 4 pounds and 11 ounces.

850. *Statement of Chas. von Rosenberg, Manchaca, Travis Co., Tex., Aug.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—Four years ago I received 10 scale carp and have received some mirror carp since. I have 3 tanks at the head of a little branch covering $\frac{1}{4}$ of an acre each, and with a depth of from 3 to 8 feet deep and a muddy bottom. There is no water flowing through them except after hard rains.

ENEMIES.—They contain frogs, turtles, and snakes. A good many carp have been destroyed by wild fowls.

REPRODUCTION.—There are about 4 or 5 of the original lot left, and they have produced a good many young this year. I have sold about 2,000. I think the scale carp thrive the best.

851. *Statement of P. S. Clarke, M. D., Hempstead, Waller Co., Tex., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in December, 1879. My pool not being ready I kept them in a wooden tank until September 28, 1880, when I put

them in the pool. It is 60 yards wide, 100 yards long, from 2 to 4 feet deep, of sandy margin, and muddy bottom. It is a natural basin in the prairie supplied with rain water.

PLANTS.—The margin of the pond has a grass the blade of which resembles prairie-grass, but the roots are matted and close-jointed. The fish love to plow among these roots.

ENEMIES.—Snakes are the worst enemy; terrapin also infest the pool, but I do not think they do any harm. The long-legged blue and white crane also visit the pool.

FOOD.—I have given them no food to speak of.

GROWTH.—There are 6 of the original lot left that will weigh about 4 pounds each. Two that were caught weighed, respectively, 2½ and 4 pounds.

REPRODUCTION.—I do not know how many young there are, but the pool seems to be full of them. They are 6 to 8 inches long. This spring's carp vary from 3 to 4 inches in length. I have disposed of 10 of the young which were from 6 to 8 inches long, to be put into another pool, and have promised more. They will overstock my pool in a very few years. I think I shall be able to supply all demands in my county for carp.

MISCELLANEOUS.—There is no difficulty with them at all. They are close imitators of our buffalo-fish. About sundown, the time they feed, I have seen the carp go out on the edge, almost completely leaving the water.

852. *Statement of C. R. Breedlove, Brenham, Washington Co., Tex., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp in December, 1881. My rain-water pond or "tank," as the Texans call it, is from 30 to 50 feet wide and from 60 to 100 feet long. It is from 2 to 5 feet deep and a large volume of water flows through it during and after heavy rains.

ENEMIES.—There are craw-fish only.

FOOD.—I give them Indian corn, corn-bread, and biscuits.

GROWTH.—I have seen some of them, while feeding them, nearly or quite 21 inches long. I do not know how many there are, but suppose they are all there.

REPRODUCTION.—I am not sure that they have yet spawned.

MISCELLANEOUS.—I was offered $5 apiece for them but would not take $10.

853. *Statement of T. W. Morriss, Brenham, Washington Co., Tex., May* 17, 1882.

DISPOSITION OF CARP RECEIVED.—I received my carp in 1880. My 4 ponds are separated by dams, and have an aggregate length of about 400 yards and a width of from 50 to 60 feet, with depths of from 3 to 10 feet and muddy bottoms. I constructed a small basin in my yard this spring, in which I placed 5 carp. My object in this arrangement was to hatch the carp in the pool and remove the young to the larger ponds when they were large enough to care for themselves.

GROWTH.—The largest of the carp are about 2 feet long.

REPRODUCTION.—I discovered in the small basin on May 10 a large number of young, which are now about 2 inches long.

854. *Statement of William Elliott, Taylor, Williamson Co., Tex., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp December 17, 1880, and some subsequently through the Texas Fish Commissioner. I have 2 ponds, one 40 by 600 feet and one 100 feet square. Both are fed by springs. There is about 3½ inches of continual overflow. The temperature is 56 degrees.

PLANTS.—They contain water-lilies and Johnson grass, or what is known as Texas-Colorado bottom-grass.

FOOD.—I have given them corn-bread, baked bread, and boiled oats.

GROWTH AND REPRODUCTION.—The old ones weigh from 15 to 20 pounds each, the young being of various weights. I have given away several lots to other parties.

EDIBLE QUALITIES.—They are very fine when cooked.

UTAH.

855. *Statement of James Toombs, Tyner, Box Elder Co., Utah, Aug.* 28, 1883.

GROWTH.—About 6 months ago I received 18 small carp. I placed them in a spring, and, noticing that some of them had died, removed them to another more suitable spring. A few days ago I examined them, and was greatly surprised at their remarkable growth.

856. *Statement of J. D. M. Crockwell, Oasis, Millard Co., Utah, Sept.* 17, 1883.

GROWTH.—Mr. Funk, of Manti, San Pete County, Utah, writes me that his fish weighed from 8 to 9 pounds last spring. By this time, of course, they are much larger.

857. *Statement of S. Francis, Morgan, Morgan Co., Utah, Dec.* 15, 1882.

DISPOSITION OF CARP RECEIVED.—The carp received a year ago have done well. I put them in a pond containing about one acre of water. The source of the spring is about 80°; the pond averages about 55°.

PLANTS.—The pond grows an abundance of vegetation.

GROWTH.—Many persons have seen the carp swimming at the top of the pond, their backs just out of the water. They judge them to be from 15 to 18 inches long, and to weigh over 2 pounds. This seems a very remarkable growth.

858. *Statement of A. Raht, South Cottonwood, Salt Lake Co., Utah, Jan.* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 60 small carp received about December 20, 1881, I put in an artificial ice-pond.

FOOD.—I fed them regularly during the winter and spring, but in the early summer I suspended feeding, as I could not see any of them.

ENEMIES.—I thought their numerous enemies had killed all, as we have sea-gulls, kingfishers, trout, and muskrats.

GROWTH.—On November 12, 1882, when the water was let out of the pond, so as to clean out weeds which might interfere with the ice-making, I found 36 large carp, the largest one weighing 2 pounds and 2 ounces, and one with scales all over, weighing about ½ pound. One of the large ones was killed for eating and showed a good deal of spawn; so that I now hope to get a large quantity of young ones in the spring.

VERMONT.

859. *Statement of Lewis H. Spear, Braintree, Orange Co., Vt., Dec.* 28, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in November, 1880. My pond is 30 by 75 feet. Its bottom is composed of mud. The depth of the water varies from 1 to 3 feet. In winter the pond is supplied with water from a spring at its head. The warm spring water prevents the pond from being closed with ice. In spring and early summer the pond receives the rain water from off of the fields, and in midsummer and autumn the supply is obtained from a clear trout stream. The amount of water is about 12 inches as a rule; in the spring it is 100 inches. In summer the temperature of the water is 50 to 80 degrees.

PLANTS AND ENEMIES.—The pond contains yellow and white lilies, cowslips, water-grasses, peppermint, and willow. It is partly shaded by the German basket-willow, which protects the fish from birds of prey. It also contains frogs.

FOOD.—In May and June the carp are fed once each day. At other seasons they do not get food regularly. I give them crackers, bread-crumbs, mush, and wheat. They eat scalded meal quite freely. They also eat boiled potatoes when mashed.

GROWTH.—I judge the 16 remaining carp will measure from 12 to 18 inches in length. They will weigh from 1 to 2 pounds. In May, 1882, the first time I had seen the carp since they were deposited in the pond, I judged they would weigh 8 ounces and would measure 8 inches in length. My carp have not increased in size or been as good feeders as I desired. I think, however, that they have increased in size twice as fast as did trout that formerly occupied the same pond. Perhaps our ponds, rivers, and lakes may be adapted to this fish, but I think the waters in this section are too cool for the carp to make rapid growth.

860. *Statement of J. W. Howard, Barton, Orleans Co., Vt., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in November, 1880. My pond is 12 by 25 feet across and 3 feet deep, with a muddy bottom.

PLANTS AND ENEMIES.—The pond contains the common water-grass of these parts; also a few frogs.

FOOD.—I give them brown bread, potatoes, and angle-worms every day.

GROWTH.—They are very shy and keep out of sight. I think they do not weigh over 2 pounds. I have not yet seen any young.

MISCELLANEOUS.—As soon as I have fish enough I shall construct another pond, as I should like to make carp culture a success. I have the scale variety, and would like the other two kinds.

VIRGINIA.

861. *Statement of John Neely, Accomack C. H., Accomack Co., Va., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—In the spring of 1881 I received 100 carp, which were placed in a small pond, from which they escaped into a mill-pond. I received 50 more afterwards. These were put in the mill-pond, the area of which is from 10 to 20 acres and full of stumps and débris. The bottom is muddy.

PLANTS.—The principal plant is the ordinary pond-lily, which abound in great numbers.

ENEMIES.—The pond contains snapping-turtles, but no fish as far as I have discovered. I do not feed the carp.

GROWTH.—The carp seem to vary in length from 18 to 24 inches. I have not caught any, as it is impracticable to use a net.

862. *Statement of John H. Wise, Accomack C. H., Accomack Co., Va., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received in April, 1881, a lot of carp, and 50 subsequently. My pond covers from 40 to 50 acres, with a depth from 4 to 7 feet in the center, getting shallower as it approaches the banks. One portion of the bottom is mud, the other hard sand. The temperature of the water is about that of other mill-ponds in the tide-water region of Virginia.

PLANTS.—Water-lilies and other grasses grow on the banks; also great quantities of grass of a soft, fine texture, which in many places reaches the surface of the water.

ENEMIES.—Snapping or fresh-water turtles, bull-frogs, sun-fish, or fresh-water perch, and a few small pike inhabit the pond. I have been unable to see any of the carp since putting them in, and do not know whether they keep concealed in the long grass or have been destroyed by the turtles and pike.

863. *Statement of Thos. M. Buck, Charlottesville, Albemarble Co., Va., July* 21, 1882.

DISPOSITION OF CARP RECEIVED.—I placed the carp received last fall in a pond, the bottom of which had been scraped to give the water a greater depth and to free the pond of the weeds that grew therein.

PLANTS.—The spring branch to which the fish have access is well supplied with weeds, &c., but the branch, except at the mouth, is quite shallow and may not be sufficient to accommodate them at spawning time.

FOOD.—I have been careful to have no other fish in the pond. During rains the shattered oats from the field above naturally wash into the spring branch, by which the pond is supplied with water, and, as no stock is allowed to run on this field, I thought oats might be sufficient to supply them with food.

GROWTH.—The carp have only been seen from time to time as they jump out of the water. From this glance I estimate them to be as large as a man's hand.

864. *Statement of Richard T. W. Duke, Charlottesville, Albemarle, Co., Va., May,* 1883.

DISPOSITION OF CARP RECEIVED.—In the fall of 1880 I received 17 carp about 2 inches long, which I placed in my ice-pond. In the spring of 1881 I also received, through a friend in Baltimore, some 30 more. All these were hatched in the year 1880. In the summer of 1881 I built another pond expressly for fish, and in the fall of that year I procured and placed in this pond about 100 carp hatched in the year 1881. In the spring of 1882 I determined to enlarge my ice-pond and convert that into a permanent fish-pond. In order to do this it was necessary to draw off the water. It was drawn off in May and the carp were caught and transferred to the other pond. I secured about 35 out of the 47 put in. No doubt some few may have escaped and some may have been buried in the mud, but the entire loss was not over 13. These carp were about 12 or 13 inches long and would have weighed, I suppose, about a pound.

FOOD.—I feed them very often with loaf-bread broken into small pieces. This floats for a time, and the fish rise to the top and take the particles of bread just as readily as a trout takes a fly, but with much more deliberation. They are quite tame, and on any warm evening, upon throwing in crumbs of bread, some 50 or more will come up to the bank and swim around almost on top of the water.

GROWTH.—These fish are doing much better than I had expected. Those which were hatched in 1880 are now about 20 inches long and I think would weigh 3 or 4 pounds. Those hatched in 1881 are about 12 inches long and weigh about a pound. The yearling

carp caught yesterday weighed 14 ounces and was 12 inches long. This remarkable growth has been attained during one summer. The 35 fish which were transferred from the ice-pond to the new pond were from 12 to 13 inches long and weighed about a pound each.

HOW TO CATCH CARP.—I concluded to try the eating qualities of one, and with a small "fly-hook," with a piece of bread, soon caught one of the yearlings hatched in 1881. I avoided the large ones by drawing out the hook when any of these approached, as I wished to save all these for breeders this year. The carp caught weighed $\frac{3}{4}$ of a pound and was 12 inches long—the growth of one summer.

EDIBLE QUALITIES.—We had it fried for breakfast and 7 persons tasted it; all pronounced it excellent. The flesh is quite firm and white, and had no taste of mud. It reminded me in appearance and flavor of the "New River cat," which is generally considered a very good fish. It has but few bones. One, a female full of roe, was fried and eaten and was pronounced by all the family as very good fish.

WHEN CARP ARE NOT FIT TO EAT.—That carp caught in July are soft in flesh and muddy in taste is not surprising, and I would inquire what fresh-water fish, except brook trout (which will not live in water over 70°) and perhaps black bass, are fit to eat in the "dog days."

THE SHAD.—The shad leaves salt water in early spring and comes into fresh water to spawn. These fish are very much improved by a run in fresh water, and are very fine in April and the early part of May. But suppose they were taken in July and August after they were "spent," are they not utterly worthless as food? Now the same thing, no doubt, is true of carp. They spawn in May and June, and a carp of 5 or 6 pounds weight will deposit from 300,000 to 500,000 eggs, and could not possibly be fit for food earlier than the middle of October or first of November.

865. *Statement of Richard T. W. Duke, Charlottesville, Albemarle Co., Va., July* 23, 1883.

DISPOSITION OF CARP RECEIVED.—My pond has a loamy bottom, water from 1 inch to 9 feet deep, and covers 3 acres. The stream which enters it would fill a 3-inch pipe, and is not very cold.

ENEMIES.—The pond contains no plants; but some minnows and frogs. I kill the frogs when I can. I have seen one turtle, but hope I have killed him. I have killed a great many enemies, such as frogs, turtle, and snakes. This spring I have killed 8 blue kingfishers and a large fish-hawk. The kingfishers destroy a great many small fish. The fish-hawk takes the large ones.

FOOD.—I feed a little corn-bread and a little loaf-bread every evening at 6 o'clock.

GROWTH.—The largest of the old ones would weigh from 6 to 8 pounds. The young ones would measure from $\frac{1}{2}$ an inch to 5 inches.

REPRODUCTION.—I have about 200 of the original fish, and think they produced no young last year, but a great many this year.

MISCELLANEOUS.—I regard carp culture as a great success. In the Forty-first Congress I voted for a Fish Commission appropriation, and think that the best vote I gave while in Congress.

866. *Statement of Richard T. W. Duke, Charlottesville, Albemarle Co., Va., Mar.* 18, 1884.

FOOD.—I feed my carp a little; they come up and take food like pigs. The ice left my pond early in February, and the carp began to move about the middle of February.

GROWTH.—Last November I caught a carp which weighed 4 pounds, and 2 that weighed $1\frac{1}{2}$ pounds each.

EDIBLE QUALITIES.—I tried the eating qualities of the carp again last November. A 4-pound carp was boiled, and the 8 persons, my neighbors and my family, who ate of it considered it very good, as good as rock. The 2 small fish weighing $\frac{1}{2}$ pound were fried, and the opinion as to its merits equally divided. About one-half considered them very good, the others detected a strong taste. I have no doubt salt water would remove this.

HOW TO CATCH CARP.—Yesterday evening, with the aid of a hook and line, my son caught 5 carp in a few minutes, but put them back, as they were small—evidently the fry of my originial carp.

VITALITY.—On Saturday evening I caught with a hook a carp which would weigh about 4 pounds. I put it in my bath-tub filled with water. Yesterday, about 8 o'clock a. m., I put the carp in a small box, surrounding it with wet moss, and forwarded it to Lynchburg by express. It reached there about 4 p. m., and I learned this morning from my friend to whom it was sent that when taken out and placed in a tub it was as lively as could be.

867. *Statement of C. H. Harman, Charlottesville, Albemarle Co., Va., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—The 25 carp received 2 years ago, I put in ½-acre pond, with a depth of 10 feet inthe deepest part, having a muddy bottom. About a 2-inch stream of spring water flows through it. No plants grow in the pond.

ENEMIES.—Large numbers of frogs and a few turtles and sun-perch inhabit the pond.

FOOD.—I give the carp corn-bread twice a week.

GROWTH.—The original carp were 18 inches long when last seen.

868. *Statement of John D. Watson, Charlottesville, Albemarle Co., Va., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—In 1881, I received 8 or 10 carp and placed them in my pond, which is about 1¾ acres in extent, with an average depth of 5 feet, and of muddy bottom. A small, continuous branch flows through the pond.

ENEMIES.—The pond is infested by many frogs and some turtles.

FOOD.—Two or three times a week I give the carp the refuse of the kitchen and the vegetable tops from the garden.

GROWTH.—Some of the original carp are from 12 to 15 inches in length.

REPRODUCTION.—I have reason to think that the young are doing very well.

869. *Statement of J. B. Townley, sr., Red Hill, Albemarle Co., Va., Jan.* 14, 1884.

GROWTH.—You were kind enough to send me 17 carp last February, about 3 inches long. Last week in getting ice we cornered one fish, between the bank, some grounded ice and a piece of floating ice, and caught it. It measured a little upwards of 12 inches in length, by 4½ in depth. It was returned unharmed to the water. Another was seen at the same time looking larger than the one caught. Both were a little sluggish in their movements. My ice pond is supplied with water at its head by a spring, where I have a pit originally 5 feet deep, and over which the water never freezes.

870. *Statement of Henry M. Price, M. D., Scottsville, Albemarle Co., Va., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—The 16 carp I received in November, 1881, I put in a pond with 3 compartments, covering an acre. Its bottom is muddy. A 4-square-inch stream of water flows through the pond. Its temperature is from 45° to 50°.

PLANTS AND ENEMIES.—Most of the swamp-grasses and plants indigenous here grow in the pond. It also contains frogs and some fresh-water terrapins.

FOOD.—I gave the carp corn, corn-bread, and sugar-corn daily.

GROWTH.—Before the dams were broken I had all of the original carp. I have only 2 now, which, in July, 1883, weighed from 6 to 9 pounds. Some of the old ones caught in Hardware River, into which my carp escaped, weighed from 5 to 6 pounds.

REPRODUCTION.—There are from 500 to 800 young in my pond. Thousands were in the pond before it broke.

DIFFICULTIES.—An oversupply of water, which resulted in the breaking of the dam, has been the most serious difficulty I have experienced in the cultivation of carp. It is my intention to put a flood-gate to the dam to prevent a like occurrence.

871. *Statement of M. W. Wallace, Yancey's Mills, Albemarle Co., Va., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—In the fall of 1880 I received 16 carp, and 19 more in the fall of 1882. The first lot I divided with a neighbor. Each of my 2 ponds is 50 feet square, has a muddy bottom and a depth varying from 3 to 5 feet. The supply of water, though moderate, is sufficient.

PLANTS.—No plants grow in the pond.

ENEMIES.—The pond contains nothing that destroys the carp.

FOOD.—I have been giving my carp wheat, and corn-bread twice a week since the 1st of June. My not feeding them prior to that time is the reason the first lot are no larger. Some of my neighbors' carp which have been fed from the first are more than twice as large as mine.

GROWTH.—I have 7 of the 8 original carp. About 2 months ago they weighed from 2 to 3 pounds each.

REPRODUCTION.—There are 200 young in the pond, which appear to be of 3 sizes; 2 inches, 4 inches, and 6 inches. On account of the different sizes, I judge that the carp spawn twice a year.

872. *Statement of S. B. Corbett, Arlington, Alexandria Co., Va., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The 19 carp I received in the fall of 1881 I put in an inlet to a pond. The pond is ¼ acre in extent, with a depth of from 3 to 5 feet, hav-

ing a muddy bottom. The inlet, 30 feet long by from 3 to 6 feet wide, is separated from the pond by a screen, which during the freshet last spring was carried away, and the carp escaped into the pond. An inch stream of water, mild in temperature, flows through the pond.

PLANTS.—There are no water-plants in the pond. Common grasses grow on the banks.

ENEMIES.—Goldfish, catfish, frogs, a few eels, and innumerable minnows inhabit the pond.

FOOD.—I have given the carp no food.

GROWTH.—The original carp are about 8 inches long. The pond appears to be well stocked with fish.

873. *Statement of Nicholas W. de Krafft, Jetersville, Amelia Co., Va., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The 16 carp I received on November 11, 1880, I put in a pond 5 miles distant, having a bottom of soft mud-washings, covering 4 acres, with a depth of from 6 inches to 9 feet. The pond is fed by small streams which supply water enough to run a mill. The temperature of the water in summer is about 60°.

PLANTS AND ENEMIES.—Cut lemon, wild oats, and cat-tail grow in the pond. Lilies and grasses grow in the shallow parts. Perch, cat, terrapins, frogs, and a few chubs inhabit it.

FOOD.—The carp get mill-sweeping and refuse.

GROWTH AND REPRODUCTION.—A carp 11 months old weighed 5¾ pounds. The young seem to be abundant, and in the heat of the day can be seen in shallow water.

DIFFICULTIES.—I caught a carp 11 months old and placed it in a prepared feed-pond, which gave way during a freshet and the carp escaped. The pond is too remote for much care, but I am building another behind my house.

874. *Statement of G. W. Mitchell, Allen's Creek, Amherst Co., Va., Nov.* 7, 1883.

GROWTH.—The carp you sent us last year are doing well. We caught one from our mill-pond, which weighed 6 pounds.

875. *Statement of W. M. Evans, Amherst C. H., Amherst Co., Va., Dec.* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received 13 carp about 3 years ago. My pond measures about 40 square rods. It is an ice-pond. Three small springs near the pond supply it with water.

PLANTS.—The pond contains various kinds of wild grass and weeds.

ENEMIES.—Small frogs, small turtles, and eels are sometimes seen in the pond. We suppose muskrats destroyed many carp. I did not feed my carp.

GROWTH.—We drew the water off this fall and we found a carp weighing 7 pounds, and 8 weighing from 2 to 7 pounds. We left about 60 carp weighing from 1 to 4 pounds.

PRODUCTION.—We do not know how many young fish there were in the pond, as we did not make a close examination when we drew off the water.

EDIBLE QUALITIES.—We have eaten the carp fried and boiled. They are like codfish in taste.

876. *Statement of H. B. Jones, Fishersville, Augusta Co., Va., Aug.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—The 16 carp which I received on November 20, 1881, I put in a pond that is supplied with spring water. In a few days they all disappeared.

877. *Statement of James R. Kemper, Fishersville, Augusta Co., Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I put the 30 carp I received in a pond immediately below a large spring of limestone water and by the side of a branch, which, overflowing 2 months later, destroyed the banks of my pond to such an extent that all of the fish escaped. I do not think there were more than ½ a dozen alive. Carp are a success here when properly handled. I will try again with a better location.

878. *Statement of James Bumgardner, sr., Greenville, Augusta Co., Va., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—Into an acre pond, having a rocky and muddy bottom, I put the 19 carp received in February, 1881.

PLANTS AND ENEMIES.—A coarse grass grows in the pond. Goldfish and bull-frogs inhabited it.

FOOD.—I feed them occasionally on bread.

GROWTH.—The 11 original carp weigh from 2 to 4 pounds each. They have done well, and have grown more rapidly than any fish I ever handled.

REPRODUCTION.—When I drew off the water a few days ago, I caught only 6 young, each about ½ inch long.

DIFFICULTIES.—The spawn was destroyed by goldfish before I had entirely rid the pond of them.

MISCELLANEOUS.—I gave a part of the original lot of carp to a neighbor who placed them in a pond of fresh spring water. On drawing off his pond a few days ago he found 8 of the original carp, but no young. He thinks the suckers then in the pond destroyed the young.

879. *Statement of Thomas A. Lightner, Greenville, Augusta Co., Va., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—I received 9 carp 2 years ago. My pond covers ½ acre, with a depth of 6 feet in deepest part, getting shallower as it approaches the spring at its head. The bottom is of mud, gravel, and clay, which I placed there. A cold spring supplies the pond with a sufficient quantity of water at all times of the year.

PLANTS.—On the edges of the pond grow swamp grasses and small quantities of moss. It contains no other fish nor reptiles.

FOOD.—Two or three times a week I feed the carp on vegetables, corn and wheat-dough, and refuse from the kitchen.

GROWTH.—I have 8 of the original carp, each of which weigh from 4 to 5 pounds. I do not know why my carp do not breed.

880. *Statement of J. O. Cundiff, Emaus, Bedford Co., Va., May* 12, 1884.

GROWTH.—I received 22 carp, from 3 to 4 inches long, in November, 1882. They are doing well, and each are now from 12 to 15 inches in length.

881. *Statement of Phil. F. Brown, Blue Ridge Springs, Botetourt Co., Va., Oct.* 29, 1883.

GROWTH.—I received 25 German carp about 12 months ago. They were very small then, but now average over 2 pounds each.

882. *Statement of W. J. Price, Fincastle, Botetourt Co., Va., Aug.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—In 1878 I received 20 carp, and in 1880, 1881, and 1882 other lots. The carp were kept in ponds ¼ of an acre in extent with muddy bottoms. The flow of water in one of the ponds is that of a 4-inch pipe, and has a temperature of from 55° to 60°. Several of the ponds contain standing water, the temperature of which in summer is 75°.

PLANTS.—Water-cress grows in one of the ponds. The others contain rushes.

ENEMIES.—One of the fresh-water ponds and 3 of the standing-water ponds contain carp only. In the other ponds are to be found chubs, suckers, and fall-fish.

FOOD.—I give the carp bread once a week.

GROWTH.—The carp received in 1878 weigh 6 pounds; those received in 1879, 3¼ pounds, and those received in 1881, 2 pounds, and are 15 inches long.

REPRODUCTION. In 2 of the ponds there are a great many young, which vary considerably in size. Some are an inch long, and others weigh ¼ of a pound each. In one of my ponds the carp have spawned only once. In the standing-water ponds I have seen no sign of their spawning.

883. *Statement of F. N. Maxey, Well Water, Buckingham Co., Va., Oct.* 10, 1882.

GROWTH.—Last season I received 16 fish. They did splendidly and grew to be 16 inches long. About 4 weeks ago we had an unprecedented big freshet, which broke my dam, allowing my carp to escape into Slate River.

884. *Statement of N. L. Kabler, Bedford Springs, Campbell Co., Va., Aug.* 15, 1884.

CARP FOR SALE.—I have 150,000 scale and mirror carp for sale, as follows:

2 to 3 inches long	$3 per hundred.
3 to 5 inches long	5 per hundred.
10 to 12 inches long	12 per dozen.
12 to 18 inches long	20 per dozen.

885. *Statement of Shotwell Powell, Keysville, Charlotte Co., Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in the fall of 1881, and 20 more in the fall of 1882. The first lot I put in several ponds varying in size. In consequence of the dams breaking I lost all of them. The ponds are supplied with an inch flow of cool water from a never-failing spring.

PLANTS AND ENEMIES.—The pond contains plants that are indigenous here. Small fish, minnows, frogs, and turtles that are common to small streams inhabit the pond.

FOOD.—A few times I have given the carp bread, crackers, and meal in small quantities.

DIFFICULTIES.—The most serious difficulty I have experienced is from an oversupply of water.

886. *Statement of Leonard P. Wheat, Berryville, Clarke Co., Va., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1879, I received 3 dozen carp and placed them in a cold-spring pond, serpentine in form, and covering about 1½ acres, in a rich meadow. The bottom is composed of clay and gravel. One million gallons of water, the temperature of which is 60° F., flow through the pond daily.

PLANTS.—Water-cress and a prodigious growth of horse-mint grow in the narrow parts of the pond.

ENEMIES.—The pond is inhabited by frogs and musk-rats. The latter are very destructive to the carp.

FOOD.—Plenty of food washes into the pond from the contiguous barn-yards and grain-fields.

GROWTH.—I have 3 or 4 of the original carp. The largest of them weigh about 3 pounds.

REPRODUCTION.—Large quantities of young have been produced.

DIFFICULTIES.—I have exterminated musk-rats many times, but they constantly reappear. I would like to procure English badger dogs with which to hunt them.

887. *Statement of J. J. Mosby, Culpeper Court House, Culpeper Co., Va., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—On November 1, 1879, I received 16 scale carp; on November 1, 1880, 16 more, and on November 11, 1881, 21 mirror carp. My pond covers about 4 acres and is from 2 to 16 feet deep. A muddy ditch 4 feet deep, 12 feet wide, and 150 feet long extends through its center. A 6-inch flow of water from a never-failing spring supplies the pond.

PLANTS AND ENEMIES.—The pond contains plants indigenous here. It is inhabited by frogs, but by no other fish than carp. One carp was killed in shallow water while spawning.

FOOD.—At irregular times I give the carp corn-bread, potatoes, wheat, corn, and refuse from the table.

GROWTH AND REPRODUCTION.—On July 14, 1882, all of the original carp were in the pond. One weighed 7½ pounds and was 22 inches in length. A great many young are in my pond.

MISCELLANEOUS.—On April 30, 1882, I transferred the larger ones to a small spawning pond which covers about ¼ acre, leaving the large pond dry until July 14, 1882, in order to destroy all other fish eggs.

888. *Statement of M. Flanagan, Flanagan's Mills, Cumberland Co., Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—In 1879 I received 8 pair carp, and 9 pair since. I put them in a 153-acre mill-pond of clear water, with a muddy bottom. It has a full supply of water.

PLANTS.—There is no dock in pond, but grass grows in the several acres of the marsh.

ENEMIES.—Pond bass weighing from 1 to 12 pounds each, silver and yellow perch up to 4½ pounds each, masons, catfish, pike, creek mullets, frogs, terrapins, and turtles inhabit the pond.

FOOD.—I give the carp no food.

DIFFICULTIES.—The number of carp put in the pond was too small for its size.

889. *Statement of George S. Bernard, Secretary Petersburg Fish and Game Protection Association, Petersburg, Dinwiddie Co., Va., Oct.* 29, 1881.

GROWTH.—The carp that we received in the fall of 1880, and which we placed in the City Park lake about December 1, 1880, seem to be promising very well. A few days

ago, the keeper of the park with hook and line caught 2 of them, each measuring from 16 to 18 inches in length.

890. *Statement of R. A. Martin, Petersburg, Dinwiddie Co., Va., Feb.* 15, 1884

DISPOSITION OF CARP RECEIVED.—About the month of December, 1880, a committee of the Petersburg Fish and Game Association removed all other fish from the lake at the Central Park and placed in this lake some 2 dozen young carp. These fish were then from 2 to 4 inches in length. About last November a few more young carp, measuring from 2 to 3 inches long, were placed in this lake by the association.

FOOD.—During the last few weeks these fish, both of the first lot and of the last lot, have made their appearance in shoals near the edge of the lake whenever bread would be thrown to them, their beautiful movements in the water proving a constant source of interest to visitors.

GROWTH.—In the month of October, 1881, 2 of these fish were captured, and measured from 12 to 18 inches in length.

HOW TO CATCH CARP.—I have never yet caught fish with rod and line which intimated by its actions that it was less ready to give up the struggle for liberty than the carp. They fight long, and are game to the very last. I used a cork on my line as in fishing for chub, pike, and other game fish. They do not bite at the hook like other fish of the sucker kind, but take the hook more like the chub. To land a carp weighing from 3 to 3½ pounds requires the use of good tackle. It was found that these fish would not bite at worms nor minnows, but would at bread, and that the best bread with which to bait the hook is the crust of a baker's loaf or roll, fastened on the hook with the crust side up.

Among the gentlemen present at the park lake at the capture of the fish was Mr. W. E. Wells, who caught some of the carp, and says that, as a source of amusement with the hook and line, they are superior to any fish he ever saw.

891. *Statement of Emanuel H. Jones, Fairfax C. H., Fairfax Co., Va., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp which I received on May 1, 1881, I put in a pond 60 by 25 feet, with a depth of from 6 inches to 3 feet. It has a muddy bottom and is fed by a constantly-running spring 20 yards distant.

PLANTS.—There are rushes and swamp-grass in the pond.

ENEMIES.—The ponds contains common frogs, but no fish nor turtles. Craw-fish let the water escape from the pond by cutting holes through the bank.

FOOD.—Once or twice a week I give the carp wheat, corn, corn-bread, and wheat bread.

GROWTH.—I have been unable to see more than 5 of the original carp, which are the size of the common shad.

DIFFICULTIES.—I am at a loss to understand why my carp have not spawned.

892. *Statement of G. W. Bell, Herndon, Fairfax Co., Va., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp that I received in April, 1882, I put in a pond 22 by 60 feet, having a muddy bottom with a depth of from 2 to 4 feet. A ½-inch stream of very cold water flows through it.

PLANTS.—Yellow lilies and cat-tail rushes grow in the pond. The pond is not inhabited by anything that injures or destroys the carp.

FOOD.—They are never fed except when we wish to see them.

GROWTH AND REPRODUCTION.—The 20 original carp each measures from 10 to 14 inches. There are 200 or more young in the pond, each about 5 inches long.

DIFFICULTIES.—I have had great difficulty to prevent dams made with stone and cement from leaking, and will again use planks in the pond I am preparing.

MISCELLANEOUS.—I propose stocking streams in this vicinity with carp.

893. *Statement of R. Welby Carter, Upperville, Fauquier Co., Va., July* 31, 1883.

DISPOSITION OF CARP RECEIVED.—The 20 carp which I received in April, 1881, I put in a ½-acre ice-pond with a depth of 3 feet. The bottom is composed of sand, clay, and 6 inches of mud. It is warm in summer, and is on the side of a small branch.

PLANTS AND ENEMIES.—Common water-grasses grow on the edges of the pond. It is infested by bull-frogs.

FOOD.—When I feed the carp, which is not often, I give them corn-bread, corn, and wheat.

GROWTH.—A year ago a carp that had been in my pond 18 months weighed 3 pounds.

DIFFICULTIES.—The branch supplying the pond dried up last summer, and I was compelled to haul water to keep the carp alive.

894. *Statement of C. E. Jones, Wilmington, Fluvanna Co., Va., May* 13, 1884.

DISPOSITION OF CARP RECEIVED.—In the autumn of 1881 I received 20 carp, and 20 more in the autumn of 1882. They were put in a pond covering about ¼ of an acre, and nothing was seen of them until a few days since, when I drained my pond to ascertain what had become of them.

GROWTH.—Out of the 40 put in there were 9 left, which weighed from 2½ to 3½ pounds each, but there were no signs of any young.

895. *Statement of A. M. Kline, Middletown, Frederick Co., Va., Nov.* 6, 1883.

REPRODUCTION.—In August I visited Mr. Thatcher's pond and saw scores of large carp and tens of thousands of small ones, from 1 to 3 inches long.

896. *Statement of J. W. Schultz, Stephenson's Depot, Frederick Co., Va., Aug.* 11, 1883.

DISPOSITION OF CARP RECEIVED.—On November 13, 1880, I received 20 carp and 20 more on the 19th of November, 1882. The size of my pond during the winter is 40 by 140 feet and from 2 to 6 feet deep, with a clayey, marly bottom. There is a 2-inch flow of water through the pond, the temperature of which is 65°. The brook which supplies the pond with water is sufficiently large to drive a mill most of the year.

PLANTS AND ENEMIES.—Moss, cat-tail, and common grasses grow in the pond. It is inhabited by minnows, frogs, and skillpots. Muskrats damage the pond by boring through its banks.

FOOD.—Since last month I have occasionally given the carp light bread and green corn.

GROWTH.—I have 4 of the original carp, each of which measures about 22 inches in length and weighs 6½ pounds.

REPRODUCTION.—There are not less than 400 young of last year's hatching which now measure from 1 to 12 inches in length.

HOW TO CATCH CARP.—In September, 1881, I caught a carp with a hook and line, which measured 11 inches in length and weighed a pound.

DIFFICULTIES.—In the fall of 1880 I had my pond cleaned out, and as the carp could not get shelter in the mud most of them perished.

897. *Statement of H. Stephenson, Stephenson's Depot, Frederick Co., Va., Aug.* 1, 1883.

DISTRIBUTION OF CARP RECEIVED.—In November, 1881, I received 22 carp and 22 more in November, 1882. My ¾-acre pond is 4 feet deep and gets shallower as it approaches the spring which supplies it with water. The bottom is of mud.

PLANTS.—Weeds, grass, and a quantity of moss grow in the pond.

ENEMIES.—The pond is inhabited by many frogs and snappers and a few water-snakes, but no other fish than carp. I am shooting these pests and hope soon to be rid of them.

FOOD.—Believing there is a sufficient quantity of animal and vegetable matter in the pond, I seldom feed them.

GROWTH.—I have been able to see only 4 of the original carp, each of which weighed 2 pounds. I suppose they would weigh double that now. I cannot tell how many young are in the pond.

898. *Statement of A. M. Maclin, Hicksford, Greenville Co., Va., Aug.* 7, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1880, I received 12 carp, which I placed in my pond, covering about 3 acres, with a depth of 2 to 3 feet. It has a black, mucky, loamy bottom, and is supplied by several small springs about ½ mile distant. Since I erected the dam only once, and then during a very dry season, have the springs ceased to run.

PLANTS.—The pond contains a plant resembling moss, which covers almost the entire surface of the water in which the roots grow. Its blossoms are yellow and always in seed. Other plants, indigenous here, also grow in the pond.

ENEMIES.—Native pond fish and numerous frogs, turtles, and terrapins inhabit the pond.

FOOD.—About 3 times a month I give the carp corn and corn-bread.

GROWTH.—I have only seen 9 of the original carp at one time, though I suppose all of them are in the pond. They seem to be from 20 to 30 inches in length and about 6 inches through the thickest part of the body.

REPRODUCTION.—There are in the pond numerous small fish with a purple and light stripe extending lengthwise. The young of 1882 are about 6 inches in length and an inch in thickness. The young of 1883 are about the size of a man's finger. I hope these young fish are carp; if so, I will construct and stock other ponds.

899. *Statement of C. M. Adkisson, Mount Laurel, Halifax Co., Va., Oct.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—I received carp in November, 1882, and placed them in the pond which I had at that time. I now have 2 ponds, the one covering ½ an acre and the other ¼ of an acre, with proper fixtures to control the influx and outflow of water.

FOOD.—I fed the carp regularly and they became quite gentle.

ENEMIES.—I noticed some young fry and continued to feed them with great delight as if they were genuine carp. I afterward, however, became fully satisfied of my delusion, and that the young fish that I had been petting were yellow perch. In order to get rid of them I constructed a second pond, drew off the old one, and destroyed the perch.

GROWTH.—To my surprise, however, I found only one, a mirror carp, which measured 17 inches in length and weighed 2 pounds and 8 ounces. This is probably the same one that I caught in July last, which then measured 10½ inches in length, and has therefore grown, in the intervening 3 months and 21 days, 6½ inches.

900. *Statement of J. R. Denton, Junction, Hanover Co., Va., Nov.* 15, 1882.

GROWTH.—In drawing my pond at the end of 10 months after the carp were placed therein only 12 fish of the original 25 were found, these being fully 10 inches long and of beautiful appearance, with 2 large bull-frogs and a few native suckers. The latter, of equal size with the young carp, had been put in the pond to test their comparative growth. The suckers had only reached the length of 5 inches and the weight of a few ounces, while the carp weighed at least a pound apiece.

FOOD.—Food, such as bread-crumbs and vegetables, was given to the carp daily.

901. *Statement of Ferdinand Davison, Richmond, Henrico Co., Va., Oct.* 25, 1882.

GROWTH.—The carp when put in last November were from 2½ to 3 inches long. The larger ones are now from 10 to 15 inches long.

902. *Statement of Rev. H. M. Jackson*, 300 *W. Franklin st., Richmond, Va., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The 32 young carp I received in October, 1880, I put in a pond in Albemarle County, 30 by 60 feet, having a soft bottom with a depth of from 3 to 5 feet. Four gallons of spring water per minute flow through the pond. When entering the pond, the temperature of the water is 65°.

PLANTS.—Some ordinary grasses, but no lilies nor other root plants are in the pond.

ENEMIES.—The pond contains a few frogs, turtles, skillpots, and a snake, but no fish.

FOOD.—Occasionally, not regularly, the carp are given corn-meal tied in sacks. In winter they are not fed.

GROWTH.—I have all of the original carp, unless some have been stolen. They measure about 18 inches in length and weigh from 3 to 4 pounds each.

REPRODUCTION.—Each year hundreds of young are hatched. They now vary in length from 2 to 18 inches.

MISCELLANEOUS.—I propose this fall to stock Busby's pond and Rivanna River with carp.

903. *Statement of W. J. Lynham, Richmond, Henrico Co., Va., Aug.* 29, 1883.

DIFFICULTIES.—The breaking of my dam caused the loss of all the carp that I received.

904. *Statement of Mathew A. Miller, Richmond, Henrico Co., Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in December, 1879, and 50 more in July, 1880. My pond covers ½ of an acre, with a depth varying from 2 to 4 feet.

The bottom is of clay. A very small stream of spring water—probably 5,000 to 6,000 gallons in 24 hours—flows into the pond. The temperature of the pond in winter is estimated at 40°, and in summer at from 60° to 70°. It contains no plants.

ENEMIES.—Perch, small catfish, a few green frogs and snapping-turtles, are in the pond.

FOOD.—The first winter and spring I gave the carp boiled corn-meal 2 or 3 times a week. Since then I have given them no food.

GROWTH.—In June, 1882, several carp were caught, which were estimated to weigh 1½ pounds.

REPRODUCTION.—There are young in the pond, but I do not know how many.

DIFFICULTIES.—The first winter, on the edges of the pond under the ice, I found a number of dead carp. Having sold my farm in June, 1882, to H. P. Morris, of Gordonsville, I know nothing of the fish since that date.

905. *Statement of Samuel P. Moore, M. D., Richmond, Henrico Co., Va., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED—On November 30, 1881, I received 25 carp. On April 13, 1883, I received 13 more. My pond covers an acre, with a depth of 5 feet. It has a sandy loam bottom and is supplied with water from never-failing springs. The pond also receives a supply of surface water. In September the water is so cold as to be unpleasant for bathing.

PLANTS AND ENEMIES.—Meadow-grasses grow in the pond. There are no other fish in the pond, but it contains some frogs.

FOOD.—I give the carp no food, as it seems to be plentiful in the pond.

GROWTH.—When I removed the carp from the spring in which I placed them while I was getting the pond ready, I missed 6. They now appear to be about 10 inches long.

REPRODUCTION.—The young seem to be from 1 to 2 inches in length.

906. *Statement of James M. Price, Ridgeway, Henry Co., Va., July* 31, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1880, I received 16 carp, which number I divided with Mr. C. A. Carter. Mr. L. L. Thomas gave me 4 more in November, 1881. My pond is ½ of an acre in extent, 6 feet deep in its deepest part, and gets shallower as it approaches the banks. It is supplied with water from 4 springs, which are cool in summer and warm in winter.

PLANTS AND ENEMIES.—The pond contains plants that are indigenous here. Suckers, bull-frogs, and turtles inhabit it.

FOOD.—About once a week I give the carp corn-bread.

GROWTH.—In the summer of 1881 I caught a carp that measured 10 inches in length and 2 inches in breadth.

DIFFICULTIES.—It is difficult to prevent the young from escaping through the outlet.

907. *Statement of E. M. Gresham, Carlton's Store, King and Queen Co., Va., Sept.* 25, 1882.

GROWTH.—The great rains of September 22 and 23 allowed my carp to escape and destroyed my dam. I succeeded in catching 7 of the fish, and the smallest one weighed 3 pounds and 1 ounce. I managed to catch 5 of them alive and put them in barrels of water; but they must have been hurt in catching them, as all of them were dead the next morning. It is decidedly a valuable fish and one that will in time furnish meat to the thousands of our inhabitants.

908. *Statement of E. M. Gresham, Carlton's Store, King and Queen Co., Va., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—In the spring of 1880 I received 17 carp in good condition, and another lot in the fall of 1881. I put them in a 1½-acre pond having a boggy bottom, with a depth of 5 feet, and fed by a strong running water.

PLANTS AND ENEMIES.—Wild oats, red betties, and other swamp grasses grow in the pond. Frogs, turtles, &c., inhabit the pond. It contains no other fish than carp.

FOOD.—As the stream supplying the pond with water drains a clover and wheat field and a large marsh, I give the carp no food.

GROWTH.—Last March the carp received in the fall of 1881 weighed about 8 pounds each.

DIFFICULTIES.—It has been difficult to keep my dam secure.

909. *Statement of O. M. Winston, King William Court House, Va., Aug.* 31, 1883.

DISPOSITION OF CARP RECEIVED.—I received a lot of carp 2 years ago and put them in a pond in which there were chub, or beach bass and ring perch. All the carp have been destroyed.

910. *Statement of F. T. Adams, Aldie, Loudoun Co., Va., Mar.* 7, 1884.

GROWTH.—This spring the carp received on November 16, 1881, had attained a length of from 12 to 14 inches and a weight of from $2\frac{1}{4}$ to $2\frac{1}{2}$ pounds. They are keen hook biters.

911. *Statement of Wm. M. McCarty, Aldie, Loudoun Co., Va., July* 26, 1884.

GROWTH.—The carp received in November, 1883, were from 3 to 4 inches long, and to-day they measure from 8 to 12 inches in length. While fishing for snappers last week I caught 3 carp.

912. *Statement of B. P. Noland, Middleburg, Loudoun Co., Va., Nov.* 3, 1884.

DISPOSITION OF CARP RECEIVED.—I received a consignment of carp November, 1881, and planted them in a pond covering an area of about an acre.

ENEMIES.—I have found a great variety of other fish in the pond.

GROWTH.—In a small way my experiment with carp has been very successful, so much so that I am anxious to continue to cultivate them. This spring Colonel Dulany and myself determined to ascertain whether there were any carp left in my pond, as I had never been able to catch nor see one. Upon drawing off the water we found 2 of the most beautiful carp I ever saw. So far as I could see these were the only carp in the pond; the others may have been carried off by the flood which broke the dam in the spring of 1882. I have the pond so arranged now as to protect it from floods, and I am anxious to procure another lot of carp.

913. *Statement of L. S. Pendleton, M. D., Frederick's Hall, Louisa Co., Va., Sept.* 30, 1883.

GROWTH.—The carp which I received from you last spring were at the time from 1 to 3 inches in length. Now they are from 10 to 12 inches long and large in proportion. Their growth has been astonishing, and none of them have died.

914. *Statement of L. S. Pendleton, M. D., Frederick's Hall, Lousia Co., Va., Dec.* 22, 1884.

ENEMIES.—I find the minks, otters, and muskrats to be the most destructive enemies of the carp.

GROWTH AND REPRODUCTION.—The 13 carp received in April, 1883, grew finely and spawned freely last spring. I am sure that there were not less than 5,000 carp in my pond, from 3 to 24 inches long, until about two weeks ago when an unprecedented water-spout went over my dams and I fear washed all of my fish into a river near by. Some of the young fish that were spawned on the 24th of last May were $10\frac{1}{2}$ inches at the time of the accident. One of the fry of last spring, that was found dead after the overflow, was full of eggs, and would have spawned next spring. I lost the carp just as they were fully established in the pond, and after an increase had been made and a growth attained which surpassed my most sanguine expectations.

915. *Statement of Wm. M. Bagley, Columbian Grove, Lunenburg Co., Va., Oct.* 8, 1882.

GROWTH.—Some of the carp received August 25, 1881, now weigh from 6 to 8 pounds. Some of them weighed over 5 pounds August 31, 1882.

916. *Statement of W. M. Coleman, Wattsborough, Lunenburg Co., Va., Mar.* 24, 1884.

GROWTH.—I received 16 carp from you February 4, 1883. To-day, being just $13\frac{1}{2}$ months subsequently, I caught one which I found to weigh 5 pounds. I returned it to the water.

917. *Statement of George Scott, Chase City, Mecklenburg Co., Va., Nov.* 23, 1882.

GROWTH.—Most of the carp received last fall are doing well. I took 11 out of my pond last week to examine them, and found they averaged 9 inches in length and a pound in weight.

918. *Statement of Joseph Ligon, Massie's Mills, Nelson Co., Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—In 1880 I received 15 carp, and 22 more in 1881. I put the carp in a 1-acre natural pond, with a depth varying from 6 inches to 5 feet.

The bottom is muddy. Water is conveyed across a hill from a large bold spring about 200 yards distant from the pond.

PLANTS.—Grass grows on the banks, but none in the pond.

ENEMIES.—The pond is inhabited by many bull-frogs, small frogs, and turtles, but no other fish than carp.

FOOD.—I feed the carp twice a week on corn-bread and cracked corn, and sometimes on wheat, rye, &c. The carp seem to relish raised flour-bread most.

GROWTH.—In the summer of 1882 I caught with a hook and line 3 carp, weighing, respectively, $3\frac{1}{2}$, $2\frac{1}{2}$, and $2\frac{1}{4}$ pounds. Before receiving your instructions, I constructed my pond in such a manner as to be unable to drain it.

REPRODUCTION.—I am at a loss to know what I am to do with the innumerable young that are in my pond. They are from 4 to 10 inches long.

DIFFICULTIES.—I fear that the severe wind storm that blew a quantity of the water out of the pond this spring caused the carp to bury themselves to such an irrecoverable depth in the mud as not to have spawned this spring.

919. *Statement of G. F. Simpson, Midway Mills, Nelson Co., Va., Nov.* 16, 1882.

GROWTH.—The carp received last fall are now from 10 to 12 inches in length, and are doing splendidly.

920. *Statement of W. H. Bridgeforth, Bellefonte, Nottoway Co., Va., Aug.* 23, 1881.

DISPOSITION OF CARP RECEIVED.—To insure the safety of the 15 carp received in November, 1880, I removed from the pond every other kind of fish. Only for a short time after placing them in the pond was I able to discover any trace of them, and had therefore concluded, the winter being a very severe one, that they had been killed out by the cold.

GROWTH.—Upon draining my pond a few weeks since I found 8 beautiful carp, weighing from 1 to $2\frac{1}{2}$ pounds each. They were not more than 3 inches long when received.

EDIBLE QUALITIES.—A more palatable dish of fish would be hard to find.

921. *Statement of C. D. Epes, Nottoway C. H., Nottoway Co., Va., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received a lot of carp in 1880, and subsequently another. My pond is $\frac{1}{4}$ acre, supplied with water from 2 springs, and has a depth of from 4 to 5 feet.

PLANTS.—Plants that are indigenous here grow in the pond. Nothing that destroys the carp inhabits it.

GROWTH.—The carp weigh from 3 to 4 pounds each.

922. *Statement of David M. Somerville, Nottoway C. H., Nottoway Co., Va., Aug.* 10, 1883.

DISPOSITION OF CARP RECEIVED.—About 3 years ago I received 45 carp. I put them into a pond which covers about $\frac{2}{3}$ of an acre and is supplied with an abundance of water from a spring $\frac{1}{4}$ mile distant. A freshet carried off all the carp. Last fall I learn that very large unknown fish were seen in Deep Creek, a tributary of Appomattox, and into which my pond empties. I think they are the carp that escaped from my pond. They were in a deep place, and would not bite a hook.

923. *Statement of H. C. Baker, Gordonsville, Orange Co., Va., Feb.* 4, 1881.

GROWTH.—The 17 carp which were received in the fall of 1879 are doing remarkably well. In October last I caught 4 of them to see what growth they had made. They weighed from $2\frac{3}{4}$ to nearly 4 pounds, the largest one only lacking about 2 or 3 ounces of attaining the latter weight. I am satisfied that they are just the fish for the waters of Virginia, and I am sure it is the only fish suited to our ponds.

924. *Statement of Jas. G. Field, Gordonsville, Orange Co., Va., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 scale carp, 3 inches long, in October, 1879, and subsequently 3 lots, one of 14, and two of 25 each. The first lot I put in a mill-pond, but afterwards transferred the remaining 7 to a $\frac{1}{2}$-acre pond which I built especially for carp. A constant stream of cool water from a small spring supplied the pond. It has a muddy bottom, with very little sand. The water is from $1\frac{1}{2}$ to 5 feet deep.

PLANTS AND ENEMIES.—Very few plants grow in the pond, but grasses common here

grow on the banks. Neither bass nor pike, but common branch fish, sun-perch, suckers, &c., inhabit the pond.

FOOD.—Occasionally I give the carp corn-bread.

GROWTH.—When last seen we had 7 original carp, each of which approximated the shad in size, and weighed about 4 pounds. I think my carp gain about a pound each year. I believe they spawned this spring. August 27, 1881, the leather carp received in the fall of 1880 and spring of 1881, were 10 inches long, and weighed from 1 to 1½ pounds.

MISCELLANEOUS.—I have disposed of some of the carp. It is my intention to stock the neighboring streams when I have young to spare.

925. *Statement of Wm. L. Hudson, Luray, Page Co., Va., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—I put the 30 carp I received April 19, 1881, and 2 subsequent lots of 10 each in 3 ponds. One of these is 60 by 100 feet, having a clayey bottom, and a depth of from 2 to 5 feet. The other ponds are 30 by 40 feet, with a muddy and sandy bottom. There is a spring in each pond.

PLANTS AND ENEMIES.—A few lilies and weeds grow near the edges of the pond. No other fish, but a few small frogs, inhabit it.

FOOD.—Occasionally I give the carp corn-meal and bread.

GROWTH.—I have all of the carp except 2. They average from 16 to 18 inches in length.

REPRODUCTION.—There are young in the pond this year, and I expect to distribute some next fall to other parties.

926. *Statement of Wm. O. Yager, Luray, Page Co., Va., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—In April, 1881, I received 10 carp, and in 1882, 10 leather carp. I placed them in a pond covering ⅜ of an acre, with a muddy bottom, and a depth of 3 feet. No overflow occurs except when we are visited by heavy rains. The water is cold at the bottom of the pond.

PLANTS AND ENEMIES.—Mosses grow on the edges of the pond. It is inhabited by frogs and skilpots, but by no other fish than carp.

FOOD.—Sometimes I give the carp curd and corn-meal.

GROWTH.—The largest carp taken from the pond weighed 1¾ pounds, and measured 15 inches in length. I think there are carp in the pond, which will weigh 3 pounds.

REPRODUCTION.—I have 300 or 400 young of this year's hatching, which are about 6 inches long.

MISCELLANEOUS.—The carp pay me well for all my trouble, and are my pets. Visitors often admire them.

927. *Statement of Wm. E. Goolsly, Chatham, Pittsylvania, Co., Va., Nov.*, 1882.

GROWTH.—Last fall I received 22 carp. They are doing well, and will now measure from 7 to 8 inches in length.

928. *Statement of L. H. Pigg, editor of the Pittsylvania Tribune, Chatham, Pittsylvania Co., Va., Sept.* 6, 1884.

CARP FOR SALE.—I have 150,000 young carp for sale at the following prices:

For 100 carp, 2 to 5 inches long	$5
For 500 carp, 2 to 5 inches long	20
For breeders, per pair	2 to 5
For a 5-gallon transportation can	1

I obtained 25 carp from the United States Fish Commission, November 11, 1881, and 20 more November 8, 1882.

929. *Statement of T. A. Elliott, Danville, Pittsylvania Co., Va., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—A 2 or 3 inch stream of water from a cool spring supplies the ½-acre pond in which I put the 20 carp that I received on January 1, 1883. It has a gravelly and mucky bottom, and the water in it is warm.

PLANTS AND ENEMIES.—Flags, rushes, and moss grass having their roots at the bottom spread upon the surface of the pond. It is inhabited by silver-roach, pond-mullet, and frogs, but by no other fish than carp.

FOOD.—About once a month I give the carp moderately-cooked corn-bread, oats, &c.

GROWTH.—The original carp appear to be in a healthy condition and are growing rapidly, approximating the herring in size. They are too young to spawn.

930. *Statement of W. P. Robinson, Danville, Pittsylvania Co., Va., Nov.* 25, 1884.

DISPOSITION OF CARP RECEIVED.—The 15 carp and 6 gold-fish which were sent by express reached me safely November 15, 1884, though there were only about 2 inches of water in the bucket which contained them. I also received 25 carp November 27, 1881. I have kept these fish in 2 ponds, one of which covers 2 acres and the other 1 acre.

PLANTS.—In my 2 ponds there are to be found lilies of all kinds, various kinds of grasses, wild rice, wild oats, calamus root, and water-cress.

FOOD.—I have been feeding my old fish all the summer on refuse from the kitchen, cabbage leaves, boiled hominy, and all kinds of vegetable refuse, cooked. I find the boiled hominy to be the best food for carp, it being of a suitable size for them to swallow. I generally feed the carp in that part of the pond where the water is from 1 to 3 feet deep.

GROWTH AND REPRODUCTION.—My carp grow $1\frac{1}{4}$ pounds a year. I have kept the leather carp in the 2-acre pond and the scale carp in the 1-acre pond. The 6 leather carp remaining spawned this year. I have about 1,000 young leather carp from 5 to 6 inches long and as broad as my two large fingers.

HIBERNATION.—The young have not gone into winter quarters yet, for every day they are to be seen swimming and jumping in the shallowest parts of the pond, where the water is from 1 to 3 or 4 feet deep.

931. *Statement of R. K. Dabney, Powhatan C. H., Powhatan Co., Va., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I put the 30 carp that I received more than 2 years ago in $\frac{1}{8}$-acre pond, having a soft, muddy bottom, with an average depth of 3 feet. The pond is supplied with water from a small spring near by.

PLANTS.—The plants that are indigenous here grow in the pond.

ENEMIES.—A great many frogs and a few terrapins infest the pond. It contains no other fish. I give no food to the carp.

GROWTH AND REPRODUCTION.—About a year ago a carp 10 inches long was caught. There are probably many young in the pond.

DIFFICULTIES.—Owing to my having sold my place soon after receiving the carp, they suffered for food.

932. *Statement of John Houston, Farmville, Prince Edward Co., Va., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp in November, 1880, 25 in November, 1881, and 20 in 1882. The $\frac{1}{2}$-acre pond, which is supplied with from 500 to 1,000 gallons of water per hour from 10 mineral springs and a free-stone spring, has a depth of from 8 to 10 feet, and a soft muddy bottom.

PLANTS.—The common flag is the predominant plant that grows in the pond. Wire-grass does well on the dam.

ENEMIES.—A few sun-perch and minnows inhabit the pond.

FOOD.—Almost every day in warm weather I give the carp corn-bread, loaf-bread, and crackers, and sometimes corn. They come in full sight to be fed, and people bring bread and feed them in order to get a good look at them.

GROWTH.—Yesterday 4 of the carp measured, respectively, 8, 12, 13, and 18 inches in length. The one 18 inches in length weighed 5 pounds. Nothing in this line could be more beautiful.

REPRODUCTION.—The young are from 4 to 8 inches long.

DIFFICULTIES.—Of the first lot a few died and others escaped when the dam broke. Something destroys the eggs. [It is the sun-perch and minnows which feed on the eggs.—EDITOR.]

933. *Statement of R. D. Miller, Farmville, Prince Edward Co., Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 16 carp that I received in November, 1880, I put in a pond an acre in extent with a depth of 7 feet. Its bottom is muddy. Two hundred gallons per day is the flow of water, the temperature of which is 72°

PLANTS.—Cresses, flags, and lilies grow in the pond.

FOOD.—Once in 24 hours I give the carp blood, bread, milk, &c.

GROWTH.—I have 16 of the original carp, each of which weighs from 4 to 6 pounds.

REPRODUCTION.—There are about 10,000 or 12,000 young in the pond. They weigh from $\frac{1}{4}$ to $1\frac{1}{2}$ pounds. My pond contains carp only.

SALES.—I have sold 64 young at 25 cents a piece.

934. *Statement of Thomas Lewis, Salem, Roanoke Co., Va., Sept.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I put the 500 carp which I received in November, 1878, in a pond 200 feet square, with a depth of 5 feet. This pond broke and all were lost except 146. There is a foot flow of water through the pond. At the spring the temperature is about 50°; that of the pond varies with the weather. The pond was entirely free from other fish, frogs, turtles, &c. In March, 1881, at which time the carp were 30 months old and weighed from 1½ to 2½ pounds each, and measured from 10 to 15 inches in length, I distributed the remaining 146 carp to the following parties: William Graybill, Amsterdam, Botetourt County, Virginia, 22 carp; D. S. Read, Roanoke, Roanoke County, Virginia, 20 carp; William Brand, Catawba, Roanoke County, Virginia, 20 carp; Institution for Deaf, Dumb, and Blind, Staunton, Augusta County, Virginia, 21 carp; William B. Dickerson, Glade Springs, Washington County, Virginia, 20 carp; N. K. White, Abingdon, Washington County, Virginia, 20 carp; S. F. Simmers, Salem, Roanoke County, Virginia, 10 carp; F. J. Chapman, Salem, Roanoke County, Virginia, 13 carp.

FOOD.—I gave the carp wheat and corn.

GROWTH.—In 5 years the original fish have obtained a weight of from 8 to 12 pounds each.

REPRODUCTION.—Thousands of young have been hatched, although the carp have not always been properly cared for.

DISPOSITION OF YOUNG.—Since I distributed the 146 original carp I have also distributed some 500 young, varying in size from 4 to 12 inches.

935. *Statement of Wm. M. Dunlop, Kerr's Creek, Rockbridge Co., Va., Aug.* 2, 1883.

DISPOSITION OF CARP RECEIVED.—I put the 16 carp received in December, 1880, in a pond ¼ of an acre (a part of a 6¾-acre pond), having a gravelly and muddy bottom, with a maximum depth of 3½ feet. About ½ a million gallons of water, the temperature of which is 62° F., flow through the pond daily.

PLANTS.—Coarse moss, resembling pine-tops, and water-lilies grow in the pond in muddy places.

ENEMIES.—White suckers, trout, California salmon, and black bass were put in the larger pond several years ago. Terrapins, bull-frogs, and lizards are natives of it.

FOOD.—I do not give the carp any food, as they feed on a soft bug, shaped somewhat like a grain of coffee, that is found among the moss in the pond.

DIFFICULTIES.—I am very much discouraged, as none of the carp have ever been seen, while plenty of suckers are caught every winter.

936. *Statement of J. K. Edmondson, Lexington, Rockbridge Co., Va., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—I received 25 carp 2 years ago and 25 more last year. The water is cold. Subsequently the carp disappeared.

937. *Statement of Daniel J. Hileman, Mill Creek, Rockbridge Co., Va., Dec.* 18, 1882.

GROWTH.—The fish which you sent me last fall have done very well. I raised several of them up on a dip-net, and they were about 10 inches in length.

938. *Statement of Jacob Senger, Baker's Mill, Rockingham Co., Va., Dec.* 12, 1881.

GROWTH.—Mr. A. Myers, of this county, has some yearling carp that average 15 inches in length. Michael B. E. Kline has some weighing 1½ lbs. each.

939. *Statement of M. B. E. Cline, Broadway, Rockingham Co., Va., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—In October, 1880, I received 16 carp, and 25 more the next year. I gave a neighbor 12 of them. My pond is 22 by 62 feet, with a depth of from 1 to 4 feet. It has a clayey bottom. A constant ¾-inch flow of cold spring water passing the dairy and through the stock-yard supplies my pond.

PLANTS.—Grass grows in the shallow water. I have willow brush in the pond.

ENEMIES.—The pond contains nothing that is destructive to the carp. I killed the only 2 turtles there were.

FOOD.—I give the carp corn-meal dough, wheat, shelled corn, bread, and refuse from the dressing of fowls. I feed my carp as regularly as I do my hogs, which is twice a day.

GROWTH.—Last October each of the 16 original carp measured 20 inches in length and 9 inches in circumference.

REPRODUCTION.—The pond is full of young.

DISPOSITION OF YOUNG.—I gave to each of 5 neighbors 5 carp.

940. *Statement of Peter Rader, Broadway, Rockingham Co., Va., Oct.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—I received 12 carp in November, 1880, and 25 in November, 1881. The first lot I placed in a pond about 120 feet in diameter, 2 feet in depth, and of muddy bottom. It is fed by a spring which yields about 180 gallons each 24 hours. It is cold at the spring, but becomes measurably warm in the pond, and flows out through a subterraneous passage.

ENEMIES.—There are no other fish in it. Frogs and skill-pots abound. I have killed one muskrat in the pond.

FOOD.—I do not generally feed them, but have given them crumbs and wheat-bread a few times when the water was very shallow.

GROWTH.—I probably have 2 of the first lot and 10 or 12 of the second lot left. Last winter a carp which was caught weighed 5½ pounds and measured 22 inches.

REPRODUCTION.—As the pond has never been drained, I cannot tell how many young there are, but have handled 70 or 75, which were 6 inches in length, and have observed many smaller ones in the pond.

EDIBLE QUALITIES.—I have eaten 3. The first was cooked with the skin on, being parboiled and fried. The others were skinned before cooking, which seemed to be an improvement. I regard the fish as delicious.

DIFFICULTIES.—The most serious difficulty has been the failure of water during the long drouth of the past summer.

941. *Statement of D. M. Rodeffer, Broadway, Rockingham Co., Va., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp in the fall of 1880, and 20 more in November, 1881. The carp are kept in an artificial pond 30 by 40 feet, from 1 to 4 feet deep, and has a clayey bottom. A 2-inch stream from a spring 60 yards from the pond supplies it with water. I put fine willow brush in the pond for them to spawn on.

PLANTS AND ENEMIES.—On the edges of the pond grow broad swamp and spear grasses, which hang into the water. Frogs infest the pond.

FOOD.—I give the carp wheat-bread daily.

GROWTH.—I have 5 of the original carp, each of which appears to be about 15 inches in length.

DIFFICULTIES.—The water broke over the banks of the pond and carried off some of the carp. I have now erected a wire screen over the top of it. A few carp have died.

942. *Statement of Geo. W. Hollar, Dayton, Rockingham Co., Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—In a pond 20 by 50 feet, with a clayey bottom, I put the 20 carp which I received in November, 1881, and the lot received in the winter of 1883. An inch stream of spring water flows through the pond.

PLANTS.—Grass grows on the banks, but not in the pond. It is inhabited by nothing that disturbs the carp.

FOOD.—I give the carp light bread and refuse from the table.

GROWTH.—The 10 original carp now remaining will weigh from 8 to 9 pounds each. Since last spring 5 have died.

943. *Statement of B. F. Michael, Dayton, Rockingham Co., Va., Aug.* 3, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp November 26, 1880, and subsequently 2 small lots. My pond has an area of 75 square feet, with a depth of 3 feet. The bottom is muddy. At the head of the pond is cold spring water, which, however, does not always flow through it.

PLANTS AND ENEMIES.—Grass grows in a portion of the pond. It is infested by a few frogs.

FOOD.—I give the carp bread irregularly.

GROWTH.—I have 9 or 10 of the original carp, which weigh from 8 to 10 pounds each.

944. *Statement of Wm. J. Miller, Dayton, Rockingham Co., Va., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1881, I received 49 carp. My pond is 14 by 40 feet, 3 feet deep and has a muddy bottom. The water passes through a 7-inch-square wire screen, and is not very cold.

PLANTS AND ENEMIES.—The pond contains moss, but no grass. Nothing injurious inhabits the pond except muskrats. I have found several dead carp.

FOOD.—I give the carp corn-meal in sacks.

GROWTH.—All of the carp except 4 jumped out of the pond. Those remaining are large, and are now in a mill-dam.

945. *Statement of Samuel Shrum, Dayton, Rockingham Co., Va., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—In 1880 I received 16 carp, and 20 more last October. I put the first lot into a pond near a mill-dam. I think the muskrats let them into the dam. The second lot I put into a pond of standing water belonging to a neighbor. I have not fed the carp.

GROWTH.—I think some of the original carp are still in the mill-dam. In June after the November when I received the carp, I caught one that was 12 inches long and 4 inches wide. About a year later I caught a carp that was 18 inches in length and 6 inches in breadth; it weighed 3 pounds. A neighbor who received 3 carp from the Harrisonburg distribution in 1880 has one that measures 2 feet in length and 17 inches in diameter.

REPRODUCTION.—Yesterday, in passing a pond in which carp were put in 1880 I was told that there were young carp also in it.

946. *Statement of John C. Wenger, Dayton, Rockingham Co., Va., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—I received 16 carp on December 6, 1881, and placed them in my pond, which is 25 by 50, feet with a depth varying from 1 to 3 feet and a bottom composed of a tough soapy soil.

PLANTS AND ENEMIES.—Weeds grow in the pond. Frogs and snakes infest it, but no turtles have appeared since I shot one.

FOOD.—The carp consume less in cold than in warm weather. In warm weather we give them bread once a day.

GROWTH.—In 1881 there were in the pond 12 of the original carp. They now measure from 15 to 20 inches in length.

REPRODUCTION.—There are young of this and last year's spawning in the pond, and they are from 3 to 4 inches long.

MISCELLANEOUS.—I was very much discouraged and feared that my carp would not increase, as I never saw any young in the pond. Lately, however, on sultry evenings I have seen last year's and this year's young swimming on the surface with their noses out of the water.

947. *Statement of John W. Bowers, Greenmount, Rockingham Co., Va., Aug.* 7, 1883.

DISPOSITION OF CARP RECEIVED.—The 16 carp which I received in December, 1880, I placed in a pond 40 by 60 feet, having a clayey bottom, with a depth of from 2 to 4 feet. It is plentifully supplied with rain water, the temperature of which in summer is moderately warm; in winter, cold.

PLANTS AND ENEMIES.—Very few plants grow in the pond. Bull-frogs and turtles infest it. There are no other fish in it.

FOOD.—Three or four times a week I give the carp bread, corn-bread, cabbage, &c.

DIFFICULTIES.—In May, 1881, my carp were apparently doing finely, but during the summer following they mysteriously disappeared.

948. *Statement of Peter Bonds, Harrisonburg, Rockingham Co., Va., Aug.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—About 2 years ago I received 16 carp, and subsequently a lot from Mr. Deckert, which I put in 2 ponds, respectively, 50 by 50 and 40 by 50 feet, with depths of from 1 to 4 feet. Spring water is turned into them daily.

PLANTS AND ENEMIES.—Rushes grow in the ponds. Muskrats destroyed all of the first lot of carp except 3, and snakes ate up all my young carp before I could exterminate them. No other fish inhabit the pond.

FOOD.—I give them light bread and corn-bread.

GROWTH AND REPRODUCTION.—Last fall the 3 original carp weighed 4½ pounds each. I obtained last summer 225 young from the 3 old carp. Last fall the young weighed 2 pounds each.

949. *Statement of Henry Pulse, Harrisonburg, Rockingham Co., Va., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—The 24 carp received in November, 1880, I placed in a stagnant pond 20 by 75 yards, with a depth of from 2 to 3 feet and a muddy bot-

tom. Except when it rains, no water flows into the pond. In winter the water seldom freezes more than 2 inches in thickness, and is warm in summer.

PLANTS AND ENEMIES.—Wild grass and mint grow in the pond. It is inhabited by frogs and turtles.

GROWTH.—We have taken out 12 of the original carp, each of which are from 12 to 18 inches long and weigh 5 or 6 pounds.

REPRODUCTION.—My fish spawned in 1882, but the spawn did not hatch. A flood of water washed out of the pond a great many of this year's young, but I put back 250 of them, which are now from 2 to 3 inches in length.

950. *Statement of Emanuel Rhodes, Harrisonburg, Rockingham Co., Va., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—In December, 1880, I received 16 carp. My pond is 17 by 75 yards, 4 feet deep, and is fed from an underground spring.

PLANTS.—Wild swamp grasses and other varieties grow in the pond.

ENEMIES.—The pond also contains catfish and frogs.

FOOD.—I frequently give the carp bread.

GROWTH.—The present size of the carp is 13 inches in length. They weigh 4 pounds. I have seen no young in the pond.

951. *Statement of James M. Rhodes, Harrisonburg, Rockingham Co., Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1881, I received a supply of carp, and subsequently another lot. My pond covers a ¼ of an acre, and is supplied with a good stream of spring water.

PLANTS AND ENEMIES.—Water-plants of a wild nature grow in the pond. Turtles and muskrats infest it, but I am catching them.

FOOD.—I feed the carp daily upon bread and refuse from the kitchen.

GROWTH.—The original carp average 3 pounds in weight.

REPRODUCTION.—There are a number of young in the pond which are the size of a man's finger.

DIFFICULTIES.—In consequence of the low water the first lot of carp died. At first the pond was not fed by running water.

952. *Statement of Michael Shank, Harrisonburg, Rockingham Co., Va., Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—In the winter of 1880–'81 I received 10 carp; last fall I received 19 more. I put the first lot in a small spring, as my pond was not ready. A freshet carried off the carp from the spring. A small quantity of water flows through the pond in wet weather. Last spring I had 5 of the old carp left.

ENEMIES.—The pond contains no other fish nor turtles, but many frogs.

EDIBLE QUALITIES.—We have eaten one carp fried in lard. All pronounced it very good.

DIFFICULTIES.—I am very much dissappointed that there have been no young yet.

953. *Statement of A. S. Rosenbeyer, Mauzy, Rockingham Co., Va., Sept.* 11, 1883.

ENEMIES.—Raising carp has proved a failure with me, on account of their being killed by muskrats and turtles. I had only 3 left of the second lot, which I gave away.

954. *Statement of Daniel Miller, Spring Creek, Rockingham Co., Va., Aug.* 11, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1880, I received 16 carp. My pond is ⅛ of an acre, with a depth of from 20 to 30 inches. It has a mucky bottom. In the pond there is a spring, near which it never freezes. The flow of water is 50 gallons per minute.

PLANTS AND ENEMIES.—The pond contains moss. A few small fish, frogs, and muskrats live in it. Some of the carp have been killed by snakes.

FOOD.—About 4 times a week we give the carp light bread.

GROWTH.—I have 7 of the original carp, which weigh from 4 to 5 pounds each. There are no young in the pond. I think the carp will spawn this summer.

955. *Statement of Jacob Thomas, Spring Creek, Rockingham Co., Va., July* 30, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1881, I received 16 carp. My pond is 25 by 60 feet, and 2 feet deep, with a bottom composed of sand, clay, and gravel. It is supplied with spring water through a 2-inch pipe. The temperature of the water is between that of spring and pond water.

PLANTS.—The weeds and clover growing on the edges of the pond hang into the water.

ENEMIES.—The pond is inhabited by turtles and frogs, but no other fish than carp.

FOOD.—About once a week I gave the carp corn-meal and wheat screenings.

GROWTH.—Seven is the greatest number of original carp I have seen. I think the largest will weigh 4 pounds.

REPRODUCTION.—It is impossible to tell the number of young produced. I have seen 100 at one time this summer.

DIFFICULTIES.—I find it very difficult to keep the frogs and turtles out of the pond.

956. *Statement of David Bowman, Timberville, Rockingham Co., Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The 26 carp which I received on November 16, 1880, I put in a pond of still, muddy water, 30 by 40 yards, with a depth of from 1½ to 4 feet. It is formed on limestone land, and has a clayey bottom.

PLANTS.—Sour-grass, smart-weed, Spanish needles, and other grasses grow in the pond.

ENEMIES.—The pond is inhabited by turtles, bull-frogs, skilpots, and catfish.

FOOD.—When I fed the carp, which was very seldom, I gave them soft corn and worms. Only one original carp has been seen. The water is very cloudy or muddy at times.

DIFFICULTIES.—When I received the carp the weather was cold, and I had to cut a hole in the ice in order to put them into the pond.

957. *Statement of Solon M. Bowman, Timberville, Rockingham Co., Va., Aug.* 4, 1883.

DISPOSITION OF CARP RECEIVED.—Into a ⅕ acre pond, having a clayey bottom, with a depth of 2 feet, I put the 16 carp I received on November 26, 1880. No water flows through it.

PLANTS AND ENEMIES.—Swamp-grass grows in ⅓ of the water's edge. Catfish, common frogs, and turtles inhabit the pond.

GROWTH.—I suppose the original carp will weigh 2½ pounds each.

958. *Statement of Sam'l H. Myers & Son, Timberville, Rockingham Co., Va., Sept.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—The 16 carp that I received I put in a pond of about 100 square feet, with a depth of from 2 to 4 feet. It has a blue potter-clay bottom.

PLANTS.—Joint-grass grows in the pond.

ENEMIES.—The pond contains no fish, but in it are frogs and turtles. The water got very low 2 years ago, when something caught the carp.

FOOD.—Grain was fed to the cattle at the pond, where they obtain water in winter. When the carp were taken from the pond I think they would have weighed 2 pounds each.

959. *Statement of Lewis Will, Timberville, Rockingham Co., Va., Aug.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—In January, 1880, Mr. J. P. Pence and myself received 37 carp. Mr. Geerge L. Will and myself received 26 more in the fall of 1881. My pond is 15 by 75 feet, and from 15 to 20 inches deep. The bottom of the pond is composed of mud. There is a regular flow of an inch of water through the pond. The temperature of the water is between spring and river water at this season of the year.

PLANTS AND ENEMIES.—A swamp, or water-grass grows on the edges of the pond. It contains bull-frogs.

FOOD.—I sometimes give the carp wheat-bread 3 or 4 times a day, and some days I do not give them any food.

GROWTH.—I have 7 of the original carp. From appearance I think they are from 15 to 20 inches long, and weigh 4 or 5 pounds.

960. *Statement of D. J. Andes, Moore's Store, Shenandoah Co., Va., Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—Three years ago I received 8 pairs of carp, and, subsequently, another lot. Moss grows in the pond, which is infested by no enemies.

GROWTH.—I have an original carp left that measures 20 inches in length. I feed corn-meal.

961. *Statement of Charles L. Swartz, Mt. Clifton, Shenandoah Co., Va., Oct.* 17, 1882.

GROWTH.—January 31 we received 20 carp, but all except 5 died before we got the pond ready in July. The 5 remaining have grown to be from 8 to 10 inches long.

962. *Statement of L. Triplett, jr., Mt. Jackson, Shenandoah Co., Va., Aug.* 9, 1883.

DISPOSITION OF CARP RECEIVED.—In December, 1880, I received 14 carp, and 20 more in the spring of 1881. My pond measures from 200 to 270 feet in length, from 60 to 75 feet in width, from 6 to 8 feet in depth, and has a mucky bottom. There is very little flow of water through the pond, except in the spring of the year.

PLANTS.—No plants grow in the pond, but it is shaded by woods.

ENEMIES.—Bull-frogs and terrapins inhabit the pond. It contains no other fish.

FOOD.—I feed the carp on wheat bran, which they seem to relish and come for like pigs. During the first 2 years I gave them nothing in addition to what blew into the pond from the adjoining grain fields.

GROWTH.—In September, 1882, several of the original carp each weighed from 6 to $6\frac{3}{4}$ pounds.

REPRODUCTION.—The pond swarms with young, which vary in size and weigh from 5 to 6 pounds.

DISTRIBUTION OF YOUNG.—I gave some young to 2 parties, who placed them in ponds with catfish.

963. *Statement of George W. Rosenberger, New Market, Shenandoah Co., Va., Sept.* 20,1883.

DISPOSITION OF CARP RECEIVED.—In November, 1882, I received 61 carp, 20 of which were obtained from the Government, the rest from friends. My pond is 60 feet in diameter, 3 feet deep, with a muddy bottom, and is supplied with water from fields as water-sheds.

PLANTS.—The pond contains moss, but since the carp have been placed there it has disappeared.

ENEMIES.—The pond contains plenty of frogs and small lizards, but no other fish than carp.

FOOD.—I do not feed the carp, but they are supplied with food by the 20 to 40 head of cattle that get water from the pond.

GROWTH.—With a dip-net I caught 7 carp, 2 of which measured, respectively, $13\frac{1}{2}$ and 14 inches in length and weighed $2\frac{1}{2}$ pounds. I think that the cultivation of carp exceeds in the amount of food which is produced that of anything else from the same area of land employed. In November, 1882, the carp which I put in my pond measured only from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches in length.

EDIBLE QUALITIES.—We ate one fried in lard. The quality was good.

MISCELLANEOUS.—I have also constructed a lake to be fed by a spring. It is 42 yards long by 10 wide. It contains *Nymphæa alba*, *Cyperus atrovirens*, and *Leersia oryzoides*.

964. *Statement of George W. Rosenberger, New Market, Shenandoah Co., Va., Mar.* 4, 1884.

GROWTH.—In a still-water pond, and a fresh-water lake that is fed by a spring, I have 90 carp which average about 20 inches in length and 3 pounds in weight. They are beautiful fish, and grow rapidly.

HIBERNATION.—They hibernated about December 1, 1883. I was able to see plenty of them almost any time in February, 1884. On throwing bread upon the water, they would come up after it very readily.

965. *Statement of Frank S. Robertson, Abingdon, Washington Co., Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—I received 14 carp in December, 1880, and 20 more in April, 1883. My pond is 40 by 100 feet, with an average depth of 6 feet and a muddy bottom. It is supplied with a 3-inch stream of water from a bold limestone spring 120 yards distant. The temperature of the water is $54\frac{1}{2}°$. The young carp received in April, 1883, died in the box in which I placed them while the pond was being drained.

PLANTS.—The pond contains the usual variety of grasses; orchard grass was sown around its banks.

ENEMIES.—Plenty of frogs and sometimes turtles and muskrats, but no other fish than carp inhabit the pond. In the craw of an Indian hen, or green heron, which is the most destructive of the fish-eating birds, I found 4 young carp.

FOOD.—The carp receive sustenance from the milk washings that flow into the pond in addition to the meal, and corn and wheat-bread which I give them.

GROWTH.—I drew off the water from the pond in June, 1882, and found 12 of the 14 original carp. But there are now only 3 remaining, all but 2 of the others having died in the box in which they were kept. These also died soon after being replaced in the pond, from injuries received in the box. Each of these 3 measure about 20 inches in length and weigh about 5 pounds.

REPRODUCTION.—The young fry vary in length from ½ inch to 1½ inches, and are from 1,000 to 3,000 in number.

DIFFICULTIES.—As I did not receive any carp in the spring of 1880, I procured and placed in my pond about 100 sun-perch and suckers, knowing the latter were not carnivorous, and supposing that the former were not. Finding the increase of the sun-perch so great, I drew off the water in June, 1882, when many thousands of the sun-perch were to be seen. I also found 12 of the 14 carp and removed them to a large box through which a constant stream of fresh water ran. I allowed the pond to remain without water until all of the bottom except 10 square feet, where the mud was 6 inches deep, was dry. The water was then turned into the pond and the carp replaced. In 3 weeks I discovered the pond to be again full of young sun-perch, the spawn evidently retaining vitality in the spot of mud. I drew the pond again last April, and allowed the bottom to get perfectly dry. Now that the pond is rid of the sun-perch I am greatly encouraged, and I have no doubt that I will be successful in the culture of carp. Purposing larger operations, I shall make other ponds this season of greater dimensions.

966. *Statement of John G. White, Abingdon, Washington Co., Va., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—About three years ago I received 15 carp, each 5 or 6 inches long. The fish are kept in a good-sized pond, having a gravelly and rocky bottom and a depth of 4 feet. A very cold spring and a large stream supply it with water, which does not freeze in winter.

PLANTS.—The pond contained a little moss, which, however, soon disappeared. There is nothing in it that disturbs the carp.

FOOD.—I give the carp bread, and intend to throw into the pond a bag of ship-stuff once a month.

GROWTH.—I have never seen them until this summer, when I counted at different times 8 or 10 of the original carp. They appeared to be from 12 to 15 inches long.

967. *Statement of Hiram V. Thompson, Glade Spring, Washington Co., Va., Nov.* 8, 1883.

DISPOSITION OF CARP RECEIVED.—About February 1, 1883, I received 12 mirror carp, which were about an inch long. My pond covers an acre, and is from 4 to 5 feet deep in places, though much of it is covered with shallow water. In April I got from a neighbor 5 scale carp a year or more old.

PLANTS.—Grass and water-oats grow over the whole of the pond.

GROWTH.—On the 30th of September I took one of the young mirror carp, which measured 18 inches. I notice that the mirror carp grow the faster.

REPRODUCTION.—In July I discovered thousands of young, some of which are now 18 inches long, and many of them are of the mirror variety, though the 5-year-old carp I got in April are scale carp. I am puzzled as to whence these young mirror carp came, as I cannot think that the carp which were an inch long in February have sufficiently matured to produce eggs.

In neither of the 4 ponds of my neighbors, from whom I got these scale carp, are there any young, although the old ones seem to thrive well. Their fish received last spring at the same time as mine are 2 inches shorter. I think it due to the way in which mine have been fed.

968. *Statement of Henry Horner, Potomac Mills, Westmoreland Co., Va., Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—The 25 carp which I received from Dr. Greenlaw in December, 1880, I put in a 25-acre mill-pond, with a depth of from 1 to 11 feet, and supplied with an abundance of spring water.

PLANTS.—Plants that are indigenous here grow in the pond.

ENEMIES.—Pike, or jack, catfish, eels, yellow perch, chub, frogs, bull-frogs, turtles, and snapping-turtles inhabit the pond. I never fed the carp.

DIFFICULTIES.—The carp were received in a healthy condition and placed in a pond which had just been rebuilt after lying idle 16 years. It was not long, however, before the dams above broke, filling my pond with trash and enemies of the carp. I do not know whether there are any carp there or whether they have been eaten by the pike.

969. *Statement of Charles M. Williams, Wytheville, Wythe Co., Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—In 1879 I received 42 carp. The mill-pond into which I put them is a mile long, 30 to 40 yards wide, and from 3 to 12 feet deep. The flow of water is enough to fill a 3½ or 4 foot pipe. There are several springs in the pond.

PLANTS.—Rushes, blue-grass, and weeds grow in the pond.. A large portion of it is well shaded by the woods that skirt the pond.

ENEMIES.—The pond contains white suckers, minnows, frogs, and turtles.

DIFFICULTIES.—We have not seen nor been able to catch any, although we believe the carp are still in the pond.

970. *Statement of Robert E. Withers, Wytheville, Wythe Co., Va., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—In the spring of 1879 I received 33 carp, and 20 more in January, 1880. My pond is from ½ to ¾ of an acre in extent and 8 feet deep, with a clayey and gravelly bottom, and is supplied with water from a spring 200 yards distant. The water has a temperature of 65° and a flow of 3 or 4 gallons per minute.

PLANTS.—Rushes, flags, grasses of various kinds, water-cresses, water-dock, and two or three varieties of algæ grow in the pond.

ENEMIES.—Water terrapins, snapping-turtles, green frogs, and water-snakes infest the pond. It contains no other fish than carp . I also find the muskrat an active depredator.

FOOD.—The carp have been regularly fed with potatoes, bread, chopped and crushed corn, and vegetables from the kitchen.

GROWTH.—Last fall some of the carp weighed 6½ and 7 pounds. Owing to the breakage of the dam in December, 1881, and in June, 1883, I have few, if any, of the original carp left.

REPRODUCTION.—There are a large number of young in the pond, and they vary much in size. The young of last year's hatching are the size of a hand.

DISPOSITION OF YOUNG.—I have given some young to several applicants to stock their ponds.

EDIBLE QUALITIES.—I have tested the edible qualities of the carp both in spring and fall months, and find them better in the latter season, just before the cold weather commences.

WEST VIRGINIA.

971. *Statement of John A. Trimble, Pepper, Barbour Co., W. Va., Nov.* 28, 1882.

GROWTH.—Of the carp received April 30, 1881, I raised 11, and this fall they measured 21 inches in length. One caught March 3, 1882, then measured 15 inches in length and 5 in breadth.

972. *Statement of George E. Showers, Martinsburg, Berkeley Co., W. Va., Apr.* 21, 1883.

GROWTH.—In November, 1881, I put 21 carp in my pond, and having seen no signs of them I concluded to draw off the water on the 13th instant. To my surprise I found them all right and of fine size. One of them, not the largest, weighed 3½ pounds. Those I have will be 2 years old this summer.

EDIBLE QUALITIES.—I had one of them cooked, and all who ate of it pronounce carp to be better than shad.

973. *Statement of J. E. Curtis, Wellsburg, Brooke Co., W. Va., Aug.* 6, 1883.

DISTRIBUTION OF CARP RECEIVED.—My pond being in an unfinished condition, an unexpected flood carried off the first lot of 20 carp which I received. About December 1, 1882, I received a second lot of 60. My pond measures 40 by 90 feet, is from 2 to 5 feet deep, and has a bottom of tough limestone, clay, and gravel. A 3-inch pipe leads from a spring to the pond, the supply of which varies very much from a full pipe in spring, fall, and winter, to a very small stream in summer. The temperature of the water is about that of large streams here.

PLANTS.—Roots of plantain and of swamp-grass grow around the edges of the pond.

ENEMIES.—The pond is infested by frogs, water-snakes, turtles, and muskrats. I found one carp half eaten, as I supposed, by muskrats. No other fish inhabit it.

FOOD.—Every 3 or 4 days since May 1, I have thrown some light bread on the surface of the water. I gave the carp clover, parsnips, beets, corn, and oats, but I have never seen them eat anything but bread. They come to the surface for bread.

GROWTH AND REPRODUCTION.—At one time I counted 24 of the original carp, each of which are from 5 to 6 inches long, and weigh about ¾ pound. I have watched carefully for young fish, but think they are too young. If I get any young this season I expect to stock another acre.

974. *Statement of John C. Covell, Romney, Hampshire Co., W. Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—In 1881 our Fish Commissioner put into the pond of the West Virginia Institute several old carp about ready to spawn. The pond, or

reservoir is 50 by 80 feet, from 2 to 3 feet deep, and has a clayey bottom, and contains from 50,000 to 60,000 gallons of water, part of which is replaced by spring water from the mountains 2 or 3 times a week. The temperature of the water is 58°.

PLANTS.—Blue-grass, clover, &c., grow in the water along the margin of the pond.

ENEMIES.—Sun-perch and common frogs inhabit the pond.

FOOD.—I feed the carp perhaps once a day. I give them stale bread, and sometimes lettuce.

REPRODUCTION.—In the fall of 1881 over 500 small carp were seined out of the pond. Possibly 100 more remained. Of these, which are now nearly 2 years old, some would weigh a pound each. One 4-year old I estimate to weigh 3 pounds.

975. *Statement of C. S. White, Romney, Hampshire Co., W. Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1879, I received 20 carp. During the first year the carp were kept in 3 small ponds, each 30 by 50 feet, having muddy bottoms. These ponds having been broken by a flood in 1880, I moved what did not escape to a pond ½ acre in extent, having a muddy bottom, and through which there is a constant flow of from 3 to 12 inches of water. The water is deep in the center and gets shallower as it approaches the sides. The temperature of the springs is 56° F. In summer the water is cool in the center of the pond and warm two-thirds of the surface. I have another pond 30 by 60 feet, in a clayey field. In summer it is at times not more than a foot deep, and for weeks not a drop of water flows into it. In winter it is about 5 feet deep. In this latter pond I put 50 young carp in the fall of 1881.

PLANTS.—The ponds contain 5 varieties of water-grasses, yellow-dock, white pond-lilies, and cresses. A few white lilies and grasses grow in the smaller pond.

ENEMIES.—Last June I cleaned out my larger pond and destroyed about 10,000 catfish, perch, and chub.

FOOD.—I give the carp in the larger pond no food except a few bread-crumbs in order to toll them into sight. From June till November I occasionally give the young carp in the smaller pond bread, refuse of the table, lettuce, cabbage, clover, and fruit.

GROWTH.—I have 6 of the original carp, one of which weighed 10 pounds the 1st of last June. They weighed considerably over a pound, October 29, 1880.

REPRODUCTION.—The carp spawned twice in 1881. In 1882 the spawn was destroyed by other fish. As yet I have seen no indication of the carp in the smaller pond spawning. I suppose the young of 1881 will weigh 3 pounds.

DISTRIBUTION OF YOUNG.—I placed 50 young in the smaller pond, and have distributed about 500.

DIFFICULTIES.—It has been difficult to prevent the young and the spawn from being destroyed by other fish. Minks, coons, and wild animals, especially muskrats, have been of much annoyance.

976. *Statement of E. W. Smith, jr., Weston, Lewis Co., W. Va., Oct.* 23, 1884.

GROWTH.—On seining my pond I find but 2 of the 21 carp planted in November, 1882. One of these measures 20 inches in length and 5 in breadth. I have 3 large ponds supplied with water sufficient for thousands of carp.

977. *Statement of Garrett Cunningham, Moorefield, Hardy Co., W. Va., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—In the winter of 1879–'80 I received 6 carp, and 10 or 15 more in the winter of 1881–'82. I put the carp in a succession of ponds, fed and connected by a small stream of warm water. The depths of the ponds vary from 2 to 10 feet.

PLANTS.—Yellow water-lilies or docks and many kinds of wild swamp-grass grow in the pond.

ENEMIES.—Mud-turtles, skillpots, and all kinds of frogs infest the ponds.

DIFFICULTIES.—Black bass appeared in the stream soon after I placed the carp there and ate them. I intend making another pond.

978. *Statement of William Sadler, New Salem, Harrison Co., W. Va., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—On December 14, 1880, I received 44 carp. I put 25 in a pond 12 by 100 feet, and 19 in a smaller pond. The depth of the larger pond is 3 feet. The bottom of the ponds are composed of mud. The amount of water that flows through them in the dry season is small. Last winter I distributed the original carp in 4 ponds, as follows: 12 carp in the first pond, 11 in the second pond, 8 in the third pond, and 7 in the fourth pond. I have 7 ponds, and will open 2 more this fall.

PLANTS.—Some of the swamp-grass in the pond is destroyed by the fish rooting it.

ENEMIES.—The pond is inhabited by frogs, snakes, and snapping-turtles, but no other fish. Last summer I saw a snake catching young carp.

FOOD.—Daily I give the carp meal, bran, corn-bread, and wheat-bread.

GROWTH.—In the fall of 1881 I had 38 carp remaining. When I drained my pond last fall I still had 38 of the original carp. Last February they would measure from 12 to 16 inches in length.

REPRODUCTION.—I got only 53 young last season. They now measure 9 inches in length. There are in all the ponds a great number of young of various sizes which were hatched this spring.

DISPOSITION OF YOUNG.—The 53 young carp hatched last year I put in a small pond by themselves. They are doing well, and the largest of them are 9 inches long. I put 150 young in 2 other ponds, and gave a neighbor 16.

979. *Statement of George W. T. Kearsley, Charlestown, Jefferson Co., W. Va., July* 25, 1883.

DISPOSITION OF CARP RECEIVED.—All but one of the 20 leather carp that I received in the winter of 1881 were lost. The 20 scale carp received the following summer I put in a pond about 60 or 70 feet in diameter, from 4 to 5 feet deep in center, with a muddy bottom. As no streams feed the pond, it is supplied with rain water, the temperature of which varies with the weather. I have other ponds to receive young fish.

PLANTS AND ENEMIES.—Mosses grow on the edges of the pond. It is inhabited by frogs, but by no turtles nor other fish than carp.

FOOD.—I give the carp boiled corn, chopped cabbage, and corn-bread as often as I deem it necessary.

REPRODUCTION.—There are young in the pond this season.

DIFFICULTIES.—When I received the carp it was very cold. Ice ½ an inch thick had formed in the can. I fear many of the carp perished. I am not sure of but one old carp still remaining.

980. *Statement of J. Ogden Murray, Charlestown, Jefferson Co., W. Va., Aug.* 3, 1883.

GROWTH AND REPRODUCTION.—Carp sent to Mr. W. H. Moore some 12 months ago are now from 10 to 15 inches long. We purpose eating them next season. There is a great increase in the stock of fish sent him.

981. *Statement of William J. Knott, Shepherdstown, Jefferson Co., W. Va., Aug.* 20, 1883.

DISPOSITION OF CARP RECEIVED.—On November 18, 1880, I received 20 carp. My pond is about 70 yards in extent, has a muddy bottom, and is 2½ feet deep. During a portion of the year a spring supplies the pond with water. No plants grow in it.

ENEMIES.—Turtles, frogs, and catfish inhabit the pond. I regard the latter as injurious, and intend to get them out.

FOOD.—I do not feed the carp.

GROWTH.—After losing and giving away some of the original carp, I have 6 or 8 that average from 14 to 16 inches in length. There are no young yet.

982. *Statement of B. A. Fleming, Fairmont, Marion Co., W. Va., Nov.* 20, 1882.

GROWTH.—The 16 small carp that I received last spring are doing very well, and are from 10 to 12 inches long.

983. *Statement of F. H. Richards, Fairmont, Marion Co., W. Va., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—In November, 1881, I received 61 carp, and 15 in December, 1882. My pond is 60 feet square, from 5 to 7 feet deep, and is supplied with cold spring water.

PLANTS.—A number of water-plants and grasses grow in the pond.

ENEMIES.—Frogs and turtles, but no other fish than carp inhabit the pond. I try to destroy the turtles.

FOOD.—Once or twice a day I give the carp corn-bread, corn-meal, potatoes, cabbage, parsnips, beans, wheat-bread, and many other kinds of vegetables.

GROWTH.—I have 60 of the original carp. In November, 1882, one year after they were received, 2 of the carp measured 12 inches in length each. There are no young yet.

DIFFICULTIES.—It has been difficult to prevent the water from breaking the dam. I am disappointed that they did not fill the pond with young this summer.

984. *Statement of H. S. White, Bellton, Marshall Co., W. Va., July* 27, 1883.

DISPOSITION OF CARP RECEIVED.—The carp I received in 1881 and 1882 I put in a pond from 18 to 24 inches deep. It is supplied with water from a spring, and has no outlet, except through an earth "dump" of the Baltimore and Ohio Railroad.

PLANTS.—Wild grasses grow in the pond. Nothing that destroys the carp inhabits it.

GROWTH.—The 10 original carp now weigh about 2 pounds each.

REPRODUCTION.—The young, of which there are not very many, vary in weight from ¼ to 1 pound.

DIFFICULTIES.—The drought of 1881 nearly exterminated the original carp.

985. *Statement of J. B. Hager, Board Tree, Marshall Co., W. Va., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—In the fall of 1881 I received 30 carp. My pond is more than ½ acre in extent, never less than 3 feet deep, with a clayey bottom. It is supplied with spring water.

PLANTS AND ENEMIES.—Grass grows in the pond, and frogs in great numbers infest it. No other fish inhabit it.

FOOD.—I feed the carp, but not as often as I should, on bread, dough, and vegetables.

GROWTH.—I have seen only 3 of the original carp, each of which when one year old weighed 4½ pounds. They do not come to the surface.

DIFFICULTIES.—I do not know the proper manner or time of feeding.

686. *Statement of Lewis W. Runner, Morgantown, Monongalia Co., W. Va., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—I received a lot of carp on April 22, 1881. My pond is 40 by 69 feet, with a depth of 6½ feet in its deepest part. It has a muddy bottom. The flow of water is ¾ of an inch. Spring water flows into the pond through a ditch a hundred yards long.

PLANTS AND ENEMIES.—Common river and swamp grasses grow in the pond. It contains no enemies but bull-frogs.

FOOD.—I give the carp bread, potatoes, lettuce, cabbage, and wheat daily.

REPRODUCTION.—Several hundred young are in the pond. They measure from 4 to 9½ inches in length. The original carp were stolen in August, 1882.

DIFFICULTIES.—A lack of water has been a great drawback to me in the cultivation of the carp.

987. *Statement of John M. Ferguson, Alderson, Monroe Co., W. Va., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—In 1881 I received 24 carp. They have been kept in ponds such as are usually found in a limestone country, in mill-dams, and in still water. The ponds are large and fed by rains. They never go dry. The mill-dams are on small creeks.

PLANTS AND ENEMIES.—Blue-grass and plants that are indigenous here grow in the ponds. Catfish, suckers, chubs, hard-shell turtles, and bull-frogs inhabit them.

FOOD.—I give the carp in the ponds corn-bread and refuse from the table and kitchen.

GROWTH AND REPRODUCTION.—The yearling carp are about 10 inches long; the old ones larger. Considerable numbers of small young have been seen in the pond this season.

DIFFICULTIES.—Turtles and small fish destroy the spawn.

988. *Statement of Rufus Houchins, Indian Creek, Monroe Co., W. Va., Sept.* 14, 1882.

DISPOSITION OF CARP RECEIVED.—I put the 1 dozen carp, 2½ inches long, received the last of April, in a small pond covering ⅛ of an acre.

GROWTH.—At the end of 4 months I drained my pond and found the growth of my carp to be remarkable. Nine of them are now 14 inches long, and 2, 12 inches long, one only being missing.

989. *Statement of Daniel Maxwell, Roney's Point, Ohio Co., W. Va., Aug.* 6, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp in 1882. My pond is 30 by 50 feet, has a muddy bottom, and is 4 feet deep. It is supplied with a flow of from 1 to 2 inches of spring water.

PLANTS AND ENEMIES.—Swamp-grass, water-flags, and calamus grow in the pond. Frogs infest it.

FOOD.—Twice a week I give the carp boiled potatoes, corn-bread, and all kinds of small grain.

GROWTH.—Five of the original carp are known to be dead. On the 1st of June the carp were 6 inches in length. There are no young yet.

DIFFICULTIES.—I find it difficult to keep the screen clear.

990. *Statement of Levi Phillabum, Valley Grove, Ohio Co., W. Va., Sept.* 8, 1883.

GROWTH.—My carp did well until a rain broke my pond, when they got out, all except one, which I caught. It weighed 4 pounds and measured 16½ inches.

991. *Statement of John K. Botsford, West Liberty, Ohio Co., W. Va., July* 28, 1883.

DISPOSITION OF CARP RECEIVED.—Two years ago I received 10 carp. My pond is 20 by 40 feet, has a loamy bottom, and is 5 feet deep. The temperature of the water, of which there is no great supply, is that of an open spring.

PLANTS.—Water-lilies grow in the pond.

ENEMIES.—Frogs, muskrats, and water-snakes infest it. When I put the carp in the pond there were about 150 gold-fish in it. I do not feed the carp.

GROWTH.—Last fall each of 4 original carp weighed from 1 to 1¼ pounds. I exhibited them at the fair grounds.

REPRODUCTION.—I have seen several schools of young of from 200 to 300 each. They measure perhaps 1½ inches in length.

992. *Statement of Andrew Mann, Forest Hill, Summers Co., W. Va., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—In September, 1880, I received 7 carp, which I put in a pond 30 feet in width. It has a muddy bottom, is 2 feet deep, and is supplied with moderately cool spring water.

PLANTS AND ENEMIES.—Clover, timothy, and weeds grow on the edges of the pond. It is infested by bull-frogs and toads.

FOOD.—Once a day I give the carp wheat-bread, corn-bread, cabbage, lettuce, and clover.

GROWTH.—I have 6 of the original carp, each of which weighs about 3 pounds.

REPRODUCTION.—There are about 200 young in the pond. They will weigh about ½ pound each.

SALES.—I have sold and given away about 150 young.

993. *Statement of P. F. Bartlett, Astor, Taylor Co., W. Va., July* 26, 1883.

DISPOSITION OF CARP RECEIVED.—The first lot of carp received were destroyed. On November 30, 1881, I received 20 more. My pond is ½ of an acre, 7 feet deep, and has a muddy bottom. A flow of cool limestone water supplies the pond with 3 gallons per minute. In the pond it gets quite warm.

PLANTS.—Bulrushes, flat-blade grass, and willows grow in the pond.

ENEMIES.—Bull-frogs, snapping-turtles, snails, mussels, and lizards live in the pond. Crawfish let out the water by digging holes in the banks. No other fish inhabit it.

FOOD.—I give the carp corn-meal, wheat, cheese, and all kinds of bread.

GROWTH.—The 20 original carp vary in length from 12 to 18 inches, and weigh from 2 to 4 pounds each.

REPRODUCTION.—From 3,000 to 4,000 young are in the pond. They measure from ½ to 3 inches in length each.

994. *Statement of E. T. Bartlett, Parkersburg, Wood Co., W. Va., Aug.* 29, 1883.

DISPOSITION OF CARP RECEIVED.—The carp which I received in November, 1880, I put in a pond 12 by 46 feet with a depth varying from 4 to 6 feet. It has a clayey bottom. Water enough to nearly fill a 3-inch pipe flows through the pond. The water passes through 2 trout ponds before it reaches the carp. The temperature of the water at the spring is 52°.

PLANTS.—The pond contains the plants that are indigenous here, and, especially, a vine which grows in an oval shape, and which is so buoyant that it eventually floats upon the surface of the water, disengaging its roots from the soil below. It is greatly admired by visitors.

ENEMIES.—Frogs, snapping-turtles, and a turtle resembling a land-terrapin inhabit

the pond. Bass and sun-fish got in through a hole that rusted in the screen. I have seen one or two dead carp on the surface.

FOOD.—Once or twice a day I gave the carp curd.

DIFFICULTIES.—The ravages of the black bass and the turtle was a difficulty with which I had to contend. It being almost impossible to keep the black bass, lake bass, sun-fish, and catfish out of the pond, I gave the carp to a neighbor. Carp and California salmon are the only kinds of fish that I have not been able to cultivate successfully.

995. *Statement of C. H. Shattuck, Parkersburg, Wood Co., W. Va., Mar.* 4, 1884.

DISPOSITION OF CARP RECEIVED.—Just a year since I received a lot of carp, and another lot subsequently, a total of 50 carp. I placed them in a small pond carefully inclosed by a tight board fence.

FOOD.—In the summer of 1883 I fed the carp.

GROWTH.—In October, 1883, I drained the pond and cleaned it, and found 39 carp in good condition, a few of them measuring 13 inches in length and none less than 10 inches.

MISCELLANEOUS.—I intend to keep the carp in the pond in which I first placed them, as they muddy the water too much in an ice-pond.

WISCONSIN.

996. *Statement of Joachem Schildhauer, New Holstein, Calumet Co., Wis., July* 24, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp in the fall of 1880. The pond is 50 feet square; has a muddy and sandy bottom.

ENEMIES.—It contains some frogs. The carp all disappeared the second season, and I think they were eaten by minks.

997. *Statement of A. J. Turner, Portage, Columbia Co., Wis., Aug.* 1, 1883.

DISPOSITION OF CARP RECEIVED.—I received 3 dozen carp in May, 1881. They were put in Mud Lake, which is about 50 rods long, 10 to 12 rods wide, and from 4 to 8 feet deep. The water is quite warm in summer.

PLANTS.—It contains water-lilies, eel-grass, &c.

ENEMIES.—It contains frogs and turtles in abundance. We suspect the carp have become food for turtles. Nothing has been heard of them since they were put in.

998. *Statement of Anton Link, East Bristol, Dane Co., Wis., Aug.* 11, 1883.

DISPOSITION OF CARP RECEIVED.—I received 15 carp in October, 1880, and 20 in November, 1882. I have 3 ponds; one, 16 by 16 feet; one, 30 by 50 feet; and another, 12 by 20 rods. They are about 6 feet deep, and the bottom is muddy and gravelly.

PLANTS.—They contain grass and water-lilies.

ENEMIES.—There are all kinds of wild fish in them, frogs, and turtles.

DIFFICULTIES.—I have spent a great deal of money with ponds and fishes, but have not had any luck with carp. I have not seen them since I put them in.

999. *Statement of Edwin Reynolds, Metomen, Fond du Lac Co., Wis., July* 31, 1883.

DISPOSITION OF CARP RECEIVED.—I received 20 carp June 14, 1881. My pond is 4 by 6 rods, of 5 or more feet in depth, and of soft clayey bottom. The spring at the west end of the pond furnishes about 6 barrels of quite cold water per hour, but the surface of the pond is quite warm.

PLANTS.—I have planted some English water-cress. There are two varieties of weeds in the pond, of which I send samples.

ENEMIES.—There are none except a few minks and a very small fish known as horned dace.

FOOD.—I have given them old bread, cooked potatoes, soaked grain, chopped lettuce, cabbage, sweet apples, &c.

GROWTH.—I saw nothing of them until July 5, 1882, when the full number of 20 came to the surface and a goodly number of small ones. They were from 12 to 16 inches in length, and were estimated to weigh 3 or 4 pounds each. I then fed them regularly every day, and could see that they increased in size very rapidly.

REPRODUCTION.—They are very busy during the spawning time running among the weeds and the little bayous. In the proper time small ones appeared in reasonable

numbers. Judging from the number of young carp that appear at or about sunset, I have somewhere in the neighborhood of 5,000. They measure all the way up to 3 or 4 inches.

DIFFICULTIES.—They hibernate in November, and fearing a severe winter I put straw and brush on the ice in December to protect them from freezing. In March I was disappointed to find that the pond was infested with minks, and several of the fish had been destroyed. I immediately set out to destroy the minks and captured 3. I found the partial remains of a number of carp on the ice, and in the spring took out 8 dead fish. I have not seen one since, and am satisfied that they were destroyed.

1000. *Statement of G. H. Kruschke, New Lisbon, Juneau Co., Wis., Dec.* 2, 1882.

REPRODUCTION.—The 20 carp received a year ago have spawned, and I have caught a number of young carp this summer.

1001. *Statement of Max Gruhle, Fillmore, Washington Co., Wis., Oct.* 13, 1884.

GROWTH.—Having lately fished our pond, we are able to report that our carp are doing well. Those planted last winter weigh from 2 to 3 pounds each, while those planted 2 years ago weigh as high as 5 pounds. They have not spawned this year. I have 3 ponds, the largest of which is an acre in extent.

1002. *Statement of Fred Doering, Winneconne, Winnebago Co., Wis., Sept.* 24, 1883.

GROWTH.—The carp I received November 16, 1882, were then about 3 inches long. This spring they were about 5 inches long, not having grown much because of the severe cold weather; but they have made up for it this summer. To-day they are 12 inches long.

1003. *Statement of Fred. Doering, Winneconne, Winnebago Co., Wis., Oct.* 25, 1884.

DIFFICULTIES.—All but 3 of the carp received last fall were destroyed during the winter by muskrats. Those remaining are alive and doing well. We have drained the pond and killed the rats, and expect no further trouble from them.

MISCELLANEOUS.

1004. *Statement of G. B. Mobley, Eutaw, Greene Co., Ala., Nov.* 8, 1880.

GROWTH AND REPRODUCTION.—I received 21 carp November 14, 1879. On going to my pond this evening I found a number of carp that weighed from 2½ to 4 pounds. These fish spawned up to about October 22, and the number of fry hatched in May I estimate at 34,000. Thus it can be seen what an immense number of young must be in my pond when even those hatched in May have grown up and spawned. I think I have all the minnows that will be needed to stock all the ponds in this section of the State. Carp are beyond doubt the most prolific fish I ever knew, and their rapid growth is truly wonderful. Those hatched in May will weigh from 1 to 3 pounds.

DISPOSITION OF YOUNG.—I have already commenced stocking the neighboring lakes and ponds, and expect to finish before cold weather sets in.

EDIBLE QUALITIES.—I have never seen so good a fish to eat; they are simply delicious. I have had them cooked at the hotel where I board, and all who ate them said the carp is superior to any of our Southern fishes.

HOW TO CATCH CARP.—I have had very fine sport fishing for them the past week. Those taken with a hook were from 4½ to 6 inches long and weighed from ¼ to ¾ of a pound each. Crickets and grasshoppers were the only bait I used, and at which they bit very rapidly.

1005. *Statement of J. C. Nicholson, M. D., Mount Meigs, Montgomery Co., Ala., Oct.* 25, 1884.

GROWTH.—I saw nothing of the 33 small carp planted in my pond in November, 1882, until yesterday, when one was taken, which, by actual weight, weighed 5 pounds, and was about 20 inches long.

HOW TO CATCH CARP.—The carp alluded to was taken with hook and line.

DIFFICULTIES.—The carp that I received in 1881 were all killed by craw-fish.

1006. *Statement of John B. Knapp, Stamford, Fairfield Co., Conn., Oct.* 7, 1884.

GROWTH AND REPRODUCTION.—I stocked Crystal Lake with leather carp about 4 years ago. A few days ago most of the water was drawn off for the purpose of repairing the dam preparatory to the expected ice-harvest. It was found that the lake was literally swarming with fish, the largest from 5 to 6 pounds in weight, and from that down to the size of the young of this season.

MISCELLANEOUS.—This is really an important incident in relation to the food supply. The experiment so successful here may be repeated indefinitely, and a new supply of excellent food-fish be available at a price within reach of all.

1007. *Statement of J. H. Post, Gainesville, Alachua Co., Fla., Dec.* 8, 1884.

GROWTH AND REPRODUCTION.—I have 5 large scale carp that were 3 years old last spring, and which now weigh from 6 to 8 pounds each. I have raised about 100 young from them this season.

1008. *Statement of A. S. Baldwin, Jacksonville, Duval Co., Fla., Dec.* 18, 1881.

DISPOSITION OF CARP RECEIVED.—Early in February, 1881, I obtained 12 carp and placed them in an inclosure in my pond. This inclosure was made of laths nailed closely together on scantling, with the lower ends projecting into the muddy bottom. Subsequently these 12 carp escaped into my ¼-acre pond. In about 6 weeks after I planted the first lot of carp I procured 6 other carp, which I also deposited in the inclosure, having previously repaired it.

PLANTS.—In the pond there is a most luxuriant growth of vegetation, so much so that about every month I am obliged to have the pond raked so as to prevent a displacement of so much of the water. This surplus vegetation is thrown upon the banks and used in fertilizing my farm. Among the plants are sweet-scented white lily (*Nymphæa odorata*), common yellow pond-lily (*Nuphar advena*), water-shield (*Brasenia peltata*), water-nymph (*Naias flexilis*), 3 varieties of bladderwort (*Utricularia*), arrowhead (*Sagittaria natans*), and many other varieties whose names have not been determined. The cells of the Utricularia are full of black seed, which, probably, furnish food for the carp.

FOOD.—I fed the last lot of carp daily, while those that escaped into the pond were sustained only by the natural productions of it. They are very fond of sweet potatoes, cooked in any manner, and also boiled cabbage. There is a large quantity of muck on the bottom of the pond, that, no doubt, contains many small insects and other forms of animal life, which, with the seeds of aquatic plants, furnish them much food.

GROWTH.—My man informed me that while raking the pond last fall he captured 2 fish, which, from the description given of them, I think must have been carp. But as their size was so much larger than I supposed possible I was yet in doubt as to their identity. He did not show me the fish, but returned them to the water. I daily sought for them, and at length I discovered 2 fish swimming together near the bottom. They were each at least a foot long and were survivors of the first lot. I then began to feed them, and they would come and suck in bits of bread, &c., floating on the water. I then opened my inclosure and let the 5 remaining carp into the pond. Although I had fed the carp in the inclosure daily, and had not given the carp in the pond any artificial food whatever, the latter were double the size of the former. I do not know how many of the original carp are in the pond, but I think that all of them remain. Some of them are at least 18 inches long and weigh 5 pounds, while all of them are more than 12 inches in length.

REPRODUCTION.—For some time past I have seen numerous small fish swimming at the bottom, and, from their shape and manner of taking food, I have reason to believe that they are young carp. They are about 3 or 4 inches long.

HOW TO CATCH CARP.—I have taken, with a hook and line, 3 carp and put each of them back again. They were over a foot long and very heavy and solid. I tried to catch some of the young with small hooks, but both the bait and hooks were taken off by the large carp.

MISCELLANEOUS.—I believe carp are adapted to the inland lakes and streams of Florida. The only apprehension I have, is the voracious character of the fish that inhabit many of our ponds, but in my pond the carp command the situation. The cat and perch have almost disappeared, while months ago, whenever I threw food in the pond, they would come and eat it. But now, as soon as the carp approach, the cat instantly make way for them. The cat are not as plenty as in former days; for I have frequently been in the habit of catching them with hook and line. I suppose I caught over 200 during last spring and summer. I doubt not but that the cat will yet be exterminated. The carp have given no evidence of hibernating, and seem to care little for what food I throw in the pond.

1009. *Statement of John A. Houser, Fort Valley, Houston Co., Ga., Nov.* 13, 1884.

DISPOSITION OF CARP RECEIVED.—About the 1st of April I procured from G. W. Singleton, of Macon, Ga., 6 mirror carp averaging about 1½ pounds in weight. At the same time I obtained from a stream near by 6 red-horse about the same size, which, with the carp, I deposited in a newly constructed pond covering over an acre and having a depth of over 4 feet in the center. This pond receives its supply of water from the rainfall only, which filled the pond about the 1st of April. Since then, however, the rainfall has been very slight, and at this writing the pond is nearly dry, there not being a sufficient amount of water in the pond to sustain the fish that are there. It has no outlet, nor does it need any for it never receives enough water to overflow its dam.

GROWTH AND REPRODUCTION.—A few days since I seined the mud-hole and procured 26 mirror carp, the young averaging a pound each.

HYBRIDIZATION.—When I seined the pond I got the 6 red-horse which I planted with the carp, and also took 100 fish which proved to be a cross between carp and red-horse. These hybrids weighed from 1 to 1½ pounds. It is a scaly fish, being of a bright color, with gold-colored spots around its neck, and having a mouth similar to that of the carp. Its dorsal fin extends from the shoulder down. The pectoral fin and the anal fin are red, and bear a more striking resemblance to the corresponding fins of the red-horse than of the carp. Is it possible to propagate this hybrid?

1010. *Statement of H. H. Cary, M. D., La Grange, Troup Co., Ga., Oct.* 16, 1880.

DISPOSITION OF CARP RECEIVED.—About 700 carp, weighing about ½ ounce each, were received in November last and distributed in small quantities to various parties in the States.

GROWTH.—So far as heard from, they have done remarkably well. One correspondent reported by letter received to-day that the fish deposited in his pond November 21, 1879, now weigh 4 pounds; others report the growth nearly as large. They are usually captured at a size of from 4 to 6 pounds, when they are at their best table qualities.

1011. *Statement of W. Foost, Fowler, Adams Co., Ill., Sept.* 27, 1882.

GROWTH.—My carp are all right and growing nicely.

1012. *Statement of J. H. Keen, Cairo, Alexander Co., Ill., Oct.* 23, 1884.

MISCELLANEOUS.—There is a leather carp in my pond weighing 7 or 8 pounds. Its body is partially covered with scales.

1013. *Statement of W. and O. Wilhelm, Florence, Stephenson Co., Ill., Oct.* 21, 1884.

DISPOSITION OF CARP RECEIVED.—A year or more ago we received 20 carp. Fifteen of them were placed in a pond near a large spring, and the remaining 5 in a pond below the first one, and fed only by a portion of the spring-flow. The 15 planted in the first pond subsequently died.

GROWTH.—The 5 carp have done well. Last week one of them measured 17½ inches in length.

1014. *Statement of A. Shinkle, Covington, Kenton Co., Ky., Dec.* 15, 1884.

GROWTH AND REPRODUCTION.—The carp received in December, 1881, have multiplied greatly and have grown to a large size. I think some of the largest will weigh 15 pounds.

1015. *Statement of Joseph Barlow, Sykesville, Carroll Co., Md., Oct.* 9, 1880.

GROWTH.—The 10 scale carp received in May last were about 3 inches long. Three months after placing them in the pond, I was surprised to find them from 7 to 10 inches in length.

1016. *Statement of John Koogle, Myersville, Frederick Co., Md., Nov.* 22, 1882.

DISPOSITION OF CARP RECEIVED.—I placed the carp received 2 years ago in a small pond with others obtained elsewhere. Last spring I removed a portion of the carp from this pond to another small one.

GROWTH AND REPRODUCTION.—I drew off the water a few days ago and found my fish to be from 12 to 16 inches long. There are a number of young, which I estimate at 1,400. There are 3 sizes of young.

1017. *Statement of John Brooks, Princeton, Worcester Co., Mass., Nov.* 9, 1884.

GROWTH.—I find that 12 of the carp received last season have attained a length of from 10 to 12 inches, and that they are as large as the fresh mackerel that are peddled from carts in this city.

1018. *Statement of Charles Dudley, Jackson, Hinds Co., Miss., Dec.* 18, 1881.

DISPOSITION OF CARP RECEIVED.—There were 12 carp placed in a pond at the lunatic asylum in December, 1880. The bottom of the pond is composed of black mud for a depth of about 3 feet. The water is very muddy.

ENEMIES.—A barrel of dead catfish and sun-perch have been taken out of the pond.

GROWTH.—One of the inmates of the asylum saw the carp in the pond and killed them. They were 19½ inches long, and weighed 3 pounds.

1019. *Statement of Lucius L. Bridges, Sedalia, Pettis Co., Mo., Apr.* 19, 1881.

DISPOSITION OF CARP RECEIVED.—As all the ponds in this vicinity were frozen over when I received my consignment of 20 young carp, I deemed it advisable to keep the fish until spring before planting them. To this end I constructed a tank or vat of yellow pine, 4 feet in length by 2 in height and depth. I covered the bottom with loam to a depth of 3 inches, and then filled it with water from Flat Creek. I caused the vat to be steamed for three days, so as to thoroughly remove all the sap from the lumber, and I then placed it in the basement of a building.

When received the carp were from ½ to 5 inches long. Fearing that the wintering of the carp in the manner described might prove a failure, I caused the 8 carp remaining to be placed in a couple of ponds in this county, 4 in one and 4 in another. Holes were cut in the ice, and the little fry were set adrift beneath their frosty covering. I learn from the proprietors of the ponds that they are alive this spring. Yesterday, I planted in a park contiguous to this city the 12 carp which I wintered in the vat. The pond is a new one, covering about 3 acres in extent, and varying from 3 to 10 feet in depth. It is supplied with water from Flat Creek, by means of the city water-works, and is not liable to go dry nor overflow.

FOOD.—Before planting the carp I scattered a peck of corn-meal and cracked wheat over the water at the place of deposit. It, of course, sank to the bottom, and as the pond is motionless, it is presumed that it will remain there for a long time, as a bed to which they can resort for sustenance. I gave directions that food be supplied at regular intervals, and always at the same place, so as to accustom them to a regular feeding place.

1020. *Statement of S. S. Hutchinson, Milford, Hillsborough Co., N. H., Nov.* 24, 1881.

GROWTH.—As I had not been able to discover but 2 or 3 of the 20 carp that were received November, 1880, I thought a snapping-turtle, which I discovered in the pond last spring, had destroyed the remainder. I have, however, lately seen 11 of the original carp, which appeared to be fully 10 inches long. These fish have received no food other than the natural resources of the pond.

1021. *Statement of Rev. John H. Brakeley, Bordentown, Burlington Co., N. J., Dec.* 4, 1884.

GROWTH.—I drew the water from my ponds last October to ascertain the condition of the adult carp that were received in 1881, as well as their increase. I found that the adult carp, which averaged 4¾ pounds last year, had grown but little during the past year, having gained on an average only 10 ounces. The 15 young fish, however, now 2 summers old, had attained an average weight of 2⅜ pounds; the largest weighed 3 pounds. Some adult carp which I had in a 2½-acre pond attained an average weight of 6⅛ pounds from 4½ pounds the year before. The largest of these weighed 7½ pounds.

REPRODUCTION.—In addition to the 12 adult carp, I found in the ¾-acre pond 2,145 young carp from 3 to 6 inches in length. My adult carp commenced spawning May 13. There were 480 young taken from the large pond, some of them being 9 inches long. When the adult carp commenced spawning May 13 they made a great commotion in the water by their rapid motion through it near the surface. The spawning continued at intervals until July 18. As early as July 18, I discovered a few young fish feeding in the margin of the pond, and on the 28th I captured 2, in a fyke, then 2 inches long.

1022. *Statement of Richard Smith, Parsippany, Morris Co., N. J., July* 24, 1883.

DIFFICULTIES.—I received 50 carp from Mr. Stone, of Morriston, about two years since. Very soon after I had put them into my pond the dam broke, and I consequently lost them.

1023. *Statement of T. V. Smith, Sharon Springs, Schoharie Co., N. Y., Jan.* 15, 1881.

GROWTH.—In May last I planted 5 carp in my pond. One of them was caught last fall and found to measure $12\frac{1}{4}$ inches in length.

1024. *Statement of Theo. Kimmel, Salem, Forsyth Co., N. C., Dec.* 4, 1884.

DISPOSITION OF CARP RECEIVED.—About a year ago I planted a lot of carp in a pond 75 by 180 feet, with a depth of from 2 inches to 5 feet, but they subsequently died. While seining in a mill-pond May 3, 1884, I caught a carp that was 6 inches long and placed it in my pond. About September 1, 1884, I procured a dozen young from 3 to 6 inches long, that were hatched the preceding May, and also placed these in the ponds.

GROWTH.—On draining my pond June 28, 1884, I found the carp planted May 3d to weigh 3 pounds. I also drained the pond November 8, 1884, and found my large carp to weigh 8 pounds. The small carp had attained a length of from 8 to 12 inches.

1025. *Statement of W. K. Hunter, Rolesville, Wake Co., N. C., Apr.* 29, 1881.

GROWTH.—I drained my one-acre pond April 19, and found the 20 carp to be $\frac{1}{5}$ larger than when they were planted March 7, 1881. Some think that they are fully as large again. For so short a time this is remarkable growth, and I deem it worthy of note.

1026. *Statement of Kemp Gaines, Springfield, Clarke Co., Ohio, Dec.* 30, 1884.

DISPOSITION OF CARP RECEIVED.—The mirror carp were received in good condition in November, 1884, and were planted in the pond with the carp received in 1880.

GROWTH AND REPRODUCTION.—I still have 12 of the carp received in the fall of 1880. I did not weigh them this fall, but ascertained that they measured from 28 to 30 inches in length. Since the fall of 1882 I have furnished spawners and young fish to stock 84 ponds. Applicants for fish this season got all they wanted, some taking as many as 40 spawners with mates, and young fish by the hundred.

1027. *Statement of W. E. Walters, Chagrin Falls, Cuyahoga Co., Ohio, Oct.* 1, 1884.

EDIBLE QUALITIES.—Last Saturday I presented 3 carp to the editor of the Chagrin Falls Exponent, who has published the following report upon them: "Three fish, weighing about half a pound each, were fried and served for dinner. In quality they equal any we have ever eaten, excepting only brook trout. The texture is fine and firm, and there are no bones excepting the back-bone and the usual attachments, as in the case of a black bass or whitefish. The flavor resembles that of a rock bass or perch more than any other fish with which we are acquainted. The slightest muddy taste was not discovered, although the pond in which they were grown has a muddy bottom. It is probable that the quality of these little fishes was better than that of a larger individual; but we are entirely satisfied that the quality of the fish will satisfy the most exacting, and that the most of people will be happily disappointed when they eat their first carp."

1028. *Statement of Seth Gifford, West Elkton, Preble Co., Ohio, Oct.* 27, 1884.

GROWTH.—Last August I discovered one of the 6 mirror carp which were deposited in my pond in November, 1883. It was about 16 inches long. I fear that this is the only one that has survived.

1029. *Statement of J. F. Hempstead, Twinsburg, Summit Co., Ohio, Oct.* 1, 1884.

GROWTH.—I placed in my pond last year some carp fry, then not over an inch long. They were hatched in the summer of 1883. I recently weighed one, which tipped the beam at 3 pounds and 10 ounces. How is that for a yearling.

1030. *Statement of C. M. Ingram, Glen Hall, Chester Co., Pa., Sept.* 20, 1884.

GROWTH AND REPRODUCTION.—I obtained 20 carp November 29, 1882, and January 26, 1883. They are now 20 inches long, and a great many young are to be seen in the

pond; in fact, the old pond is full of them. I have built another pond near it covering $\frac{1}{2}$ of an acre, and I also purpose building a third one.

GROWTH AND REPRODUCTION.—Writing subsequently under date of November 21, 1884, Mr. C. W. Ingram says: "I received 40 carp in December, 1882. There are in my pond 25 leather carp weighing from 4 to 5 pounds each, and about 5,000 of this year's fry."

1031. *Statement of Fred. Kunze, Cornwall, Lebanon Co., Pa., Oct.* 22, 1884.

GROWTH.—I have 14 carp remaining of the lot received several years ago. They weigh from $1\frac{1}{2}$ to 2 pounds, 2 of them turning the scale at the latter weight.

1032. *Statement of B. Short, Chatham Valley, Tioga Co., Pa., Nov.* 18, 1884.

FOOD.—I feed the carp on wheat kernel, boiled potatoes, and millet-seed.

GROWTH AND REPRODUCTION.—I received 4 carp April 18, 1883, and planted them in a pond covering about $\frac{1}{2}$ of an acre. At that time the fish weighed less than a pound each, while 2 fish I caught September 18, 1884, weighed $5\frac{1}{2}$ pounds each—a growth of $4\frac{1}{2}$ pounds in 17 months. I am unable to state the exact number of young, but I estimate it at 1,000. They are now 8 inches long.

1033. *Statement of R. J. Donaldson, Georgetown, Georgetown Co., S. C., Dec.* 1, 1884.

DISPOSITION OF CARP RECEIVED.—Of the 19 adult carp which I received April 12, 1884, I lost 3 shortly after their arrival, these being sick at that time. During the summer I lost 3 more. The season was very favorable and the pond full of grass, lilies, &c. There is a continual supply and flow of good, fresh water all the year.

ENEMIES.—With a dip-net I have taken hundreds of small menhaden, bream, &c. Four weeks ago the watchman saw a half-grown alligator going into the pond from the canal. He set the trap and remained at the pond a day and a night. The following morning the alligator was caught. On opening, I found in him a fine, whole carp, very fat.

DIFFICULTIES.—To my great surprise I cannot find any young carp, although it is just possible there may be some in the pond. All surroundings pointed to a large amount of spawn, and I can only account for no young upon the theory that all the adults were males. The one caught by the alligator and one that jumped from the pond in the night and died, were males containing a large quantity of milt.

1034. *Statement of R. L. Bouton in behalf of John Low, Saulsbury, Hardeman Co., Tenn., Dec.* 6, 1884.

DISPOSITION OF CARP RECEIVED.—The 20 carp sent me in 1879, Mr. John Low planted in an artificial pond, 50 by 100 feet, with a depth of 10 to 12 feet in the middle. No water flows through the pond.

PLANTS.—Some water plants grow in the pond.

ENEMIES.—The pond contains no other fish, frogs, turtles, &c.

FOOD.—The carp are fed on corn-meal. I was at the fish pond October 9, 1884, in company with Mr. John Low and Mr. H. Wright and saw the fish fed. Mr. Low struck the plank fence a few raps and then the water, when the fish began to come from deep water for their food. As I sat in a chair at the brink of the water I could see the carp at a distance of about 50 yards swimming near the top of the water. They fed not 2 yards from my feet, and ate the corn-meal like pigs do shelled corn.

GROWTH AND REPRODUCTION.—I cannot state the number of carp, nor the number of young there has been produced; but there are carp in the pond all the way up to 10 pounds.

EDIBLE QUALITIES.—I have eaten plenty of carp fried, and found them very good food.

1035. *Statement of M. T. Peebles, Johnson City, Washington Co., Tenn., Dec.* 4, 1884.

DISPOSITION OF CARP RECEIVED.—I received an assignment of carp in December, 1882, but all but 4 subsequently died. I also received some mirror carp in December, 1883, but all of them perished, having evidently been injured during transit. To the 4 carp remaining of the lot received in December, 1882, I added 14 other scale carp in July, 1883. I have also received 20 mirror carp on the 24th ultimo, which I have hope of saving. None have died thus far.

REPRODUCTION.—The 4 remaining carp of the lot planted in December, 1882, gave an increase of 20 in July, 1883, under very unfavorable circumstances. Twelve of the 20 carp hatched in July, 1883, were wintered, by way of experiment, in 14 inches of water under a covering of moss, and in July, 1884, they gave a limited increase, as the others had done in July, 1883. The 14 scale carp planted in July, 1883, produced several thousand young in May, June, July, and August, and so distinct and well defined in size as to leave no doubt on the mind of the observer as to their age.

From the 2 experimental tests to which the carp have been subjected, I am fully satisfied that when spawned and hatched naturally they will always give an increase in the latitude of Tennessee at the expiration of 12 months from the time they are hatched, if kept under favorable circumstances. The increase will not be great the first year; nor will it be great the second and third years as compared with the same kind of fish at the age of 5, 6, or 7 years.

Fifty carp that were hatched last July, I am now keeping in a pond by themselves for the purpose of determining as nearly as possible what the increase is in the first year.

1036. *Statement of C. W. Rummel, Round Top, Fayette Co., Tex., Nov.* 12, 1884.

ENEMIES.—On drawing off the pond we found a hard-shell turtle and some catfish.

GROWTH.—One year ago I received 12 small carp. To-day I found 3 only, but they had grown to be from 16 to 18 inches in length.

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XXXIV.—THE DEVELOPMENT OF THE OYSTER (OSTREA EDULIS L.).*

By Dr. R. Horst.

I.—Historical.

More has been written on the history of the development of the oyster than on that of any other invertebrate. The cause of this doubtless is the circumstance that from time immemorial the oyster has been considered a great delicacy, and that therefore attention was early directed to its development.

Brach [1] (1690) seems to have been the first to use the microscope in observing the embryo of the oyster. According to this author, the oysters found in the Venetian waters produce spawn towards the end of spring, during the entire summer, and in the beginning of autumn, which spawn they discharge into the water. During this time the central round and fleshy part of the oyster diminishes in volume and loses its succulence, while the branchia and the edge of the mantle assume a harder and more solid appearance. The liquid seen in the shell round the body in the beginning looks whitish, clear, and fluid, but later changes to a blackish mass having the consistency of pap.

When this mass is examined under the microscope, one finds in it eggs in two different stages of development: (1) Some entirely white, not altogether spherical, and resembling pellets; these eggs are quiescent and consequently less developed; (2) Others which are also white and round, but a little more compressed; they have the form of a grown oyster and show a black line in the place where the little valves will open. These last-mentioned eggs, moreover, move about and maintain a spiral motion in the mother shell. This continues until the eggs are more developed (*usque ad perfectiorem animationis gradum*). Later the oyster closes its shell, so that the water from the outside cannot penetrate into it, and the mother oyster becomes very lean, because she has to feed her offspring. During this time the young oysters gradually

* "*De Ontwikkelingsgeschiedenis van de Oester.*" From *Tijdschrift der Nederlandsche Dierkundige Vereeniging.* Supplement No. 1, Leyden, 1883–84. Translated from the Dutch by Herman Jacobson.

[1] D. Jac. Brachii: *Observ. CCIII, De ovis Ostreorum. Ephemer. Acad. Leop. Nat. Cur.*, Ann. VIII, 1690, p. 506.

assume the form of the grown oyster, and become of a black color. Either owing to the lack of water, or because they need no movement for their further development, they remain quiescent in the shell until they are ejected by the mother oyster, and then they adhere to various objects, such as wood, mud, stones, &c.

Leeuwenhoek[2] (1695) seems to have known and observed the eggs of the oyster independently of Brach. From a letter dated the 18th day of the calends of September, we learn that an oyster opened on August 4th was found filled with an enormous number of young oysters, which moved about rapidly in the water by means of the small organs which projected from their shells and which they drew in when they died (*velum auct.*). They resembled the grown oyster as much as one egg resembles the other, but they were so small that, according to Leeuwenhoek's calculation, it would take 1,728,000 to make a ball one inch in diameter. Leeuwenhoek seems also to have observed younger stages of development; at least in a later letter (dated the 15th day of the calends of September) he states that he found in some oysters a number of small unborn young, which were much less developed than those which he had previously observed, and which he could not be sure were alive.

Two years later he wrote to the Royal Society of London[3] that one day, when eating oysters at the house of a relative at Rotterdam, he found one which was partly filled with a gray mucus. As he was in doubt whether this mucus contained oyster eggs, he took some home and examined it under a microscope, when he found that his supposition was correct, as this apparent mucus was entirely composed of young oysters.

Baster[4] (1759) added but little to the above observations. He does not agree with Leeuwenhoek and others who say that the sexes are separated among the oysters. He thinks that the oyster is a genuine hermaphrodite, because it cannot move about at will and consequently cannot approach the female for the purpose of impregnation.

Home[5] (1826) says but little of the spawn of the oyster, and what he says is not very accurate, much less so, in fact, than the statements of persons who had preceded him, and whom he does not even quote in his work. He says that about the end of June the eggs issue from the ovaries, and that towards the end of July none are found either in the ovaries or in the oviducts; that the moment the egg leaves the oviduct a kind of purplish mucus is secreted, which probably serves as nourishment to the oyster during its stay in the cavity of the mantle. Once in that cavity, the eggs often fall a prey to little aquatic worms which slip into the shell. His paper is accompanied by several figures of the brood of the oyster.

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[2] A. van Leeuwenhoek: *Arcana Naturæ*. Opera, T. II, Epist. 92 and 94.

[3] Philosophical Transactions, vol. xix, 1698, p. 798.

[4] Job Baster: *Natuurk. Uitspanningen*, 1759, p. 73.

[5] On the mode of breeding in the oyster. Phios. Transact., 1827, p. 39, Plates II and IV.

Lovén[6] (1848) cannot be passed by in silence, for his exhaustive researches on the development of the *Modiolaria*, *Cardium*, *Montacuta*, and *Mytilus* serve as the basis of our knowledge of the embryology of the Lamellibranchiata. Although he has not observed the development of the oyster, nor that of any other form of the group *Monomyaria*, he has studied the representatives of widely different families of the *Dimyaria*, and the results of his researches have, therefore, a wide scope. He describes in succession the expulsion of the polar globule, the cleavage, the inclusion of the vegetative by the animal pole, the formation of the velum, the origin of the shell, the origin and differentiation of the intestinal canal, &c.

Davaine[7] (1852) is the first who gave a detailed description of the development of the oyster. According to him, the period during which the oyster contains spawn extends from the beginning of June till the end of September. He also observed spawn in the beginning of May; but this must be attributed to the higher temperature of the shallow basins where he observed it. After having directed attention to the difficulties encountered in studying the development of the oyster, caused by the circumstance that the eggs are retained in the cavity of the mantle, whence they cannot be removed without bringing their development to a standstill and causing their death, he describes the changes observed in the egg before it begins to segment. Sometimes the germinative vesicle is missing altogether, while in others another smaller vesicle is found attached to the germinative vesicle. Sometimes there is a germinative vesicle half the usual size, while at other times there are two of the same size, but only half the size of the ordinary vesicle. (This description leads us to believe that Davaine had at that period observed in the egg of the oyster some of the phenomena of fecundation made known to us at the present day through the researches of Hertwig, Selenka, Fol, and others.)

The first stage of segmentation which was observed consisted in the formation of four *blastomeres*. These are of different sizes, and generally three small segments are found adherent to a larger one. These segments, or cells, divide several times, diminish in volume, but increase in number, so that finally the egg contains nothing but small cells. Finally, the egg which had been round becomes heart-shaped. The incision which gives this last-mentioned form to the egg soon disappears, and at two points of the outline vibratile cilia begin to appear. Opposite these groups of vibratile cilia there appeared on the edge of the egg a transparent streak. This is the beginning of the hinge of the valves. During the following period the vibratile cilia become longer and more distinct, and a crown of them is formed, which indicates the

[6] S. Lovén: *Bidrag till Kännedomen om utvecklingen af Mollusca Acephala Lamellibranchiata. K. Vetensk. Akad. Handlgr.*, 1848.

[7] C. Davaine: *Recherches sur la génération des huîtres*, with 2 pl., in *Comptes Rendus et Mém. de la Soc. de Biologie*, vol. iv, 1852, p. 297.

front part of the body, while opposite (therefore at the posterior part) the hinge is found. The central mass becomes more clearly defined, and is separated from the ectoderm by a certain space. Later, the two valves of the shell become visible round the hind part of the body. The central mass is divided into two parts, one of which, of a darker color, perhaps corresponds to the liver, while the other, which begins to exhibit dilating and contracting movements, becomes the intestinal canal. The shell of these embryos is already composed of a calcareous substance.

While the embryo continues to grow the ciliary apparatus increases in dimensions, so that it seems to form, so to speak, a separate organ from the rest of the body, by means of which the embryo can swim in any direction. Gradually the basis of the ciliary apparatus decreases in size, so that finally it is attached to the body only by a thin stem, which breaks in due time. The ciliary apparatus which thus becomes detached has the shape of a round cushion, having in the center an opening which corresponds to the mouth aperture. The digestive canal assumes the shape of a retort, inclosing the liver in its concave part; the wide part of the retort forms the stomach, and the narrow part the intestines, which, owing to their general development, elongate and form a loop, which is plainly visible. Davaine was not able to observe with any degree of certainty either the mouth or the anus or the organs of sight and hearing. The appearance of the branchia is indicated by a very distinct vibratile movement on the side of the body. At the same time there was observed below the mouth aperture a small pear-shaped and transparent organ, the rapid pulsations of which show that it is the heart. The embryos probably remain in the mantle cavity of the mother oyster more than a month. Their number in a good-sized oyster has been estimated at 1,125,000.

De Lacaze-Duthiers[8] (1854), who, after Davaine, had occupied himself during two summers with the study of the development of the oyster, has in several respects continued and completed the observations of his predecessor.

1. The oyster is a hermaphrodite. Fecundation takes place in the efferent canals of the genital gland, and segmentation commences immediately after the eggs have been set free. The egg is generally divided into four, sometimes two, and rarely three segmentation spheres. From these first four spheres there are formed, as it were by a budding process, small transparent hyaline spherules, which increase so as soon to cover entirely the dark and granular spheres forming the vitellus, so much so that soon there can be distinguished in the egg a peripheral and a central portion; the embryo then becomes heart-shaped; at the depression which corresponds to the dorsal part there

[8] H. De Lacaze-Duthiers: *Mémoire sur le développement des Acéphales Lamellibranches* (Ostrea) in *Comptes Rendus de l'Ac. de Sc. Paris*, vol. xxxix, p. 103. Also *Nouvelles observations sur le développement des huîtres*, same work, p. 1197.

appear two tufts of vibratile cilia. Finally, the shell is formed from two thickenings of the epiblast, resembling a pair of watch-crystals of great transparency, attached on each side to the dorsal depression. The two halves in growing approach each other, finally join, and form the hinge. This, therefore, is not the first to appear.

The central and opaque part of the embryo is then detached from the peripheral part, first at the dorsal side and finally at the ventral side, except in two places, namely, the places occupied by the mouth and by the anus. At this latter point the central part is again joined to the peripheric layer, or epiblast, by a cylindrical stem, which elongates and finally is transformed into the intestines. The stomach is formed in the upper portion of the central mass, and the liver in the lower portion. Two groups of vibratile cilia encircle the pole opposite the shell like a wreath, which is the beginning of the trochal disk, and in the center of which the mouth forms. The intestine and the stomach form a distinct cavity, which is lined with ciliated epithelium. Soon the shell has grown so large that it incloses the entire body; in front of the anus there is found an appendage resembling a rudimentary foot. Although the trochal disk principally serves as an organ of locomotion, it has also something to do with respiration, and probably also with the taking of food. Even in the more developed larvæ neither branchia nor heart could be observed, nor any movement of the trochal disk, as stated by Davaine.

2. He succeeded once in keeping the larvæ alive, outside the mother shell, for thirty, and at another time for forty-three days. In order to follow the development of the intestines, the larvæ were fed on different colored substances. The mouth seems to be placed between the trochal disk and the foot-shaped appendage in front of the anus; it is a long funnel lined with vibratile cilia, the upper lip being formed by the disk itself, and the lower lip by the appendage in question. A tubular organ which is found in the center of the trochal disk has, in less developed larvæ, been mistaken for the mouth. The stomach is narrower in the middle, in the place where the intestines are attached. The intestines, forming a loop, turn toward the left side of the stomach. Then the lobes of the liver become hollow, and the characteristic granules commence to show themselves in the parenchyma. The streaks of fibrous appearance change to bundles of muscles, and attach themselves to the trochal disk, which they force back into the shell. He has never seen the trochal disk, or velum, detach itself spontaneously, but it sometimes happens that the shell in closing abruptly either cuts it off wholly or in part. The hinge of the shell is provided with teeth, as in young mussels. Finally, the otoliths also make their appearance in the form of vesicles which inclose granules, agitated by a very lively movement and placed under the mouth at the base of the lower labium or lip.

Coste[9] (1861), the zealous advocate of fish-culture in France, describes

[9] *Voyage d'exploration sur le littoral de la France et de l'Italie*, 2d ed., 1861, p. 93.

the appearance of the embryos of the oyster when seen through the microscope, and he gives some tolerably exact illustrations of them. As it is possible to keep these larvæ alive, outside of the mother shell, for several days, he thinks that this may become an important industry.

De la Blanchère[10] (1866) reports almost exactly the same as Davaine and Coste. He also gives four good drawings showing larves of the oyster, in which he shows the longitudinal muscles and the dorsal and ventral muscles which cause the velum to be drawn back into the shell. He says that, according to the observations of Mr. Gerbe, when the larve of the oyster becomes properly defined, the velum dies, as the branchiæ develop, so that it is probable that they have their origin in this organ.

Gwyn Jeffreys[11] (1869) observed the spawn of oysters when he examined an oyster fishery in the river Roach in Essex. He compares the larvæ to the grains of seed of the shepherd's-pouch. He says that the body can be seen through the transparent shell; the central portion is opaque, almost black, and probably represents the liver. The front part only is provided with vibratile cilia.

Saunders[12] (1873) exhibited, at the session of July 10 of the East Kent Natural History Society, live larvæ of oysters, and stated that they have a small shell, the two valves of which are convex, while in the grown oyster one is convex and the other flat.

Salensky[13] (1874) gives in his *Bemerkungen über Haeckels Gastræa theorie* good illustrations of the three different phases of the development of the oyster larvæ. These illustrations serve as an example of the development of the lamellibranchiates, which, according to him, have no alimentary organ. The embryo is originally composed of two layers without an internal cavity, and the intestinal cavity only makes its appearance later in the endoderm.

Möbius (1877), in his charming little work, *Die Auster und die Austernwirthschaft*, gives some illustrations of the first stages of the development of the *Ostrea edulis*. He also gives a very accurate drawing of the larva (with the adductor muscle); by mistake, however, this figure is reversed, so that the velum is placed below. He found that the young oysters leave the mother when they have reached the size of 0.15 to 0.18 millimeter.

We must finally mention some reports regarding two other species, namely, the American oyster (*Ostrea virginiana*) and the Portuguese oyster (*Ostrea angulata*).

According to Brooks[14] the American oyster (*Ostrea virginiana* List),

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[10] H. de la Blanchère: *Industrie des Eaux*, 1866, p. 69.

[11] British Conchology, vol. v, 1869, Supplement, p. 165.

[12] Quart. Jour. Microsc. Science, vol. xiii, 1873, p. 493.

[13] *Archiv für Naturgeschichte*, 1874, p. 150, Plate V, Figs. 1, 2, and 3.

[14] Studies from the Biological Laboratory of Johns Hopkins University, No. 4, Baltimore, 1880, plates I–X.

is unisexual; its eggs are fecundated and develop outside the mother oyster. The progress of segmentation depends a good deal on the temperature and other circumstances. In some cases the embryo, provided with vibratile cilia, is formed two hours after fecundation; but the ordinary duration of the process is not less than twenty-four hours, and may even extend over more than two days. At the beginning of segmentation the egg assumes an oval shape. the thick end becomes the animal pole (formative, Brooks), and the small end the vegetative pole (nutritive, Brooks). This latter corresponds to the dorsal side of the embryo. During violent movements of the vitellus the first polar globule issues from it. There does not seem to be any segmentation cavity such as is observed in the eggs of other mollusks. After repeated segmentations of the animal spheres, whose number is still further increased by other spheres, originating in the vegetative part, a layer of ectoderm cells is formed which covers the vegetative sphere, and as it grows larger completely envelops it. The vegetative sphere is first divided into two entodermic cells, whose number afterwards increases to six and more. The embryo is flattened out, and the ectoderm and entoderm become detached from each other. Finally, the entoderm is invaginated, so that in form it resembles a shallow cup with a shallow gastric cavity. The embryo now undergoes an important change; a crown of vibratile cilia is formed, and in the dorsal part, transversely to the great axis of the body, a depression begins to appear which represents the blastopore. This finally closes, and the entoderm, a mass of cells, is inclosed in the peritoneal cavity. But prior to this there appears, at each extremity of the depression of the blastopore, a small irregular transparent body; these are the two valves. A couple of hours later, the embryo has considerably increased in size, and there may be seen forming in the entoderm a cavity which is lined with a vibratile epithelium. This cavity communicates with the outside by an aperture which is almost opposite the shell, so that small molecules can enter. The edges of the aperture may turn toward the outside and thus act as a suction apparatus. Meanwhile the shell has assumed a regular shape, and has grown so much that it covers nearly half the surface of the body. Soon a second aperture appears, through which the intestines communicate with the outside; this is the anus; while the stomach now becomes pear-shaped. Its larger part is turned forward, and on the fourth or fifth day a diverticle appears on each side of the stomach; these are the two halves of the liver, in the sides of which small globules of oil may be seen which strongly refract the light.

The study of the development of the American oyster, therefore, teaches us these four things:

1. That there is a gastrular stage caused by invagination.

2. That the blastopore closes, and that the anus and the latter do not coincide.

3. That the shell appears at a point originally occupied by the blastopore.

4. That a first and then a second opening is formed connecting the mesenteron with the exterior almost opposite the place where the blastopore is found; and that one of these openings becomes the mouth and the other the anus.

Winslow[15] (1881), while on board the American vessel Saratoga, during the summer of 1880, observed the development of an oyster from the Bay of Cadiz, which he took to be the common oyster (*Ostrea edulis*). but which, as Dr. Hoek has already remarked, was probably the Portuguese oyster (*Ostrea angulata*). As Mr. Winslow did not discover any embryos in the shell, he attempted artificial fecundation and was entirely successful. After five hours the eggs had produced well developed larvæ, provided with a velum, a shell, and a mesenteron, all of which could be plainly distinguished. The manner in which the development took place resembled very much that of the *Ostrea virginiana.*

Bouchon-Brandely[16] (1882) has studied the mode of propagation of the Portuguese oyster (*Ostrea angulata*) which at present is acclimatized at the mouth of the Gironde. This oyster is unisexual; its eggs develop outside of the mother, and may, therefore, be cultivated in sea-water. He believes if experiments made in this respect with the *Ostrea edulis* did not succeed, this is caused by the considerable quantity of albumen which the liquid of the mantle cavity contains, in which the larvæ of this oyster develop. According to Bouchon-Brandely, this essential difference in the organization of these two species makes all attempts at cross-breeding absolutely impossible, and thereby also excludes the possibility of a bastard form which some oyster cultivators say exists. Experiments made in this respect have proved entire failures. The fecundation of the *Ostrea angulata*, on the other hand, has proved successful. The eggs and the spermatozoa, when in water, preserve their vitality for several hours. Excellent results were obtained by using the sexual products taken two or three hours previous from the genital organs. The embryos began to move, according to the temperature, in from 7 to 12 hours after fecundation. The shell formed about the sixth or seventh day.

Finally, Ryder[17] (1883) speaks of the mode of fixation of the larvæ of the American oyster. Assisted by Col. Marshall McDonald, he succeeded in obtaining larvæ of the eggs of the *Ostrea virginiana* artificially fecundated. These larvæ, after twenty-four hours, adhered to the sides

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[15] An account of an experiment in artificially fertilizing the ova of the European oyster (*Ostrea edulis*). Report of Ferguson, commissioner of fisheries of Maryland, 1881.

[16] *De la sexualité chez l'huître ordinaire* (*O. edulis*) *et chez l'huître portugaise* (*O. angulata*). *Comptes Rendus*, &c., vol. xcv, p. 256.

[17] On the mode of fixation of the fry of the oyster. Bulletin of the U. S. Fish Commission, vol. ii, 1882, p. 383.

of the glass vessels in which they were. They became so firmly fixed that a strong current of water could not detach them. He could not discover with any degree of certainty in what manner they were attached; but, although he admits the possibility of the existence of a filamentous byssus, he supposes that the fixation takes place by means of the edge of the mantle which protrudes from the shell; because he has often seen the larva resting on its side, and the edge of the mantle protruding from the valves. Before the larval period comes to an end the straight line of the hinge disappears more or less as the shell grows. When the larva has become fixed, new layers of shelly matter are deposited round the edges, presenting a prismatic structure. During this growth the hinge end is slightly lifted up, so that it is clear that shell matter is deposited along the edge. The lower valve is so firmly attached to the collector by the organic matrix of the shell (the conchyoline) that it cannot be torn from it without breaking it.

II.—Personal Researches.

These observations were made during the summers of 1881 and 1883, at our branch station of Wemeldinge,[18] where I received all the assistance that could possibly be rendered from Messrs. Zocher and De Leeuw. The parks found in the neighborhood, in which the larvæ of the oyster were allowed to affix themselves, proved very useful for my researches. The study of the development of the oyster is beset with difficulties, which has led Professor De Lacaze-Duthiers to say with good reason that "the oyster is certainly one of the species of the group of the acephalous lamellibranchiata, the study of whose organization and development is exceedingly difficult."[19] With most of the lower grades of animals the sexes are separated, and the sexual products, when mature, are ejected; consequently fecundation takes place outside of the body. It is entirely different with the oyster. Not only do its embryos pass the first stages of their development in the mantle cavity of the mother oyster, and fecundation takes place inside and not outside, but the eggs and the spermatozoa probably meet in the excretory canals of the sexual gland. If one wishes to observe the first changes of the fecundated egg, this cannot be done, as with most of the lower grades of animals, by artificial fecundation; but one is obliged to open a certain number of oysters containing eggs. If one opens a mother oyster in the ordinary manner—that is, by cutting the adductor muscle of the shell—it soon dies, and the normal development of its offspring is consequently disturbed. Embryos separated from the mother oyster may be preserved alive in an aquarium, but they either soon become sick or their development stops entirely. Thus Professor De Lacaze-

[18] See the Sixth Annual of the Zoological Station.

[19] *Mémoire sur le développement des Acephales lamellibranches.* In *Compt. Rend.*, Paris, vol. xxxix, p. 1197.

Duthiers says that his oyster larvæ lived for more than a month in aquariums, but he could not observe any important changes in their organization, which certainly does not indicate a normal condition. I once succeeded in observing the development of oyster larvæ for a couple of hours, by making a small opening in the edge of the shell, which hurt the animal scarcely at all. I was thus enabled to introduce a small pipette into the mantle cavity and remove the larvæ, but this lasted only a short time, because with each operation so many embryos were removed that all were soon taken. It is, therefore, not possible to procure a continuous series of the different phases of the development. In addition there is another difficulty, namely, that one cannot always recognize the mother oysters from the outside. The relaxation of the adductor, and consequently the less firm closing of the valves, is a pretty sure indication that the oyster contains embryos; but this phenomenon is more marked in those oysters which contain more highly developed embryos, which are on the point of being ejected from the shell. For this reason I have often perceived more mother oysters containing advanced embryos than those which contained young embryos. And for this reason likewise the first stages of the segmentation of the egg have to a great extent remained unknown to me.

C. Davaine[20] and Professor Möbius[21] have, however, given illustrations and descriptions of some of the early phases of the segmentation of the egg of the oyster. It is there seen that after the polar globules have been ejected (Fig. 2), the egg divides, like those of other lamellibranchiata,[22] into two spheres; the smaller, the animal, and the larger, the vegetative sphere (Fig. 3). This stage is followed by another, during which the egg is composed of four spherules, three smaller than the animal pole, resting on a large vegetative spherule (Fig. 4). By repeated segmentation of the animal spheres, and the formation of smaller spheres, originating by budding from the vegetative sphere, there is formed on the animal pole a layer of small cells which gradually envelop more and more the vegetative sphere, without, however, inclosing it entirely (Fig. 5). Then the vegetative sphere also begins to divide, first into two large segments (Fig. 6), later into several cylindrical cells. Thus two layers are formed, one of which will develop into the ectoderm and the other into the entoderm (and into the mesoderm ?). At the same time the embryo loses its spherical form and, owing to a depression on the lower side, becomes slightly reniform (Fig. 7, where, however, the lower part is turned upside down). If one observes an optic section of a more advanced stage (Fig. 8), one sees that the layer of entodermic cells has a slight depression and that a genuine gastrula has been formed. There can, however, be no question of a genuine invagination, because there

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[20] See his work already referred to, p. 34, Plate II.

[21] See his work already referred to, p. 16.

[22] The *Pisidium* seems to form an exception. Ray Lankester: Contributions to the develop. history of the Mollusca, in Phil. Transact., vol. 165, 1876.

is no cavity of segmentation; we have here, so to say, an intermediate form between an embolic gastrula and an epibolic gastrula. This latter form seems, moreover, to occur with other marine lamellibranchiata. Rabl[23] and others have also shown that these two types of the gastrula, so different in appearance, are connected together by a series of intermediate forms, and may be accounted for by the same process. The embryo of the oyster during this phase presents a remarkable phenomenon, namely, that there is not only an invagination at the vegetative pole, but also a very distinct depression at the other pole, a little below the dorsal side. When seen from the side, this depression of the embryo is noticed at once (Fig. 9, *sk*), and an imaginary line (drawn as shown in Fig. 8) shows at once that it is due to a slight invagination of the ectodermic cells. During the further development (Figs. 10 and 12) there is formed a small depression, composed of high cylindrical cells, with a narrow opening; the bottom of this depression is turned toward the dorsal pole of the embryo, while the opening is found across the large axis of the embryo. This little pouch is certainly nothing else but the preconchylian gland, as is shown by observations of more advanced stages. The opinion of Fol,[24] that in the oyster the preconchylian gland is not an invagination properly so-called, but only an ectodermal enlargement, is therefore not correct, and rests probably on observations of more advanced larvæ, in which, as in other mollusks with an outer shell, the invagination gradually disappears. This organ was first discovered by Mr. Ray Lankester in the *Pisidium* and several gasteropods;[25] later Mr. Hatschek discovered it in *Teredo*.[26] If one compares these two species with *Ostrea edulis*, it will be found that the preconchylian gland appears very early in the embryonic life of the latter. The first naturalists who have studied the history of the development of the oyster, Messrs. Davaine and De Lacaze-Duthiers, speak of an "*échancrure*" and of a "depression," which gives to the embryo a shape resembling a heart. They seem, therefore, to have known of this invagination, although they did not discover its true significance. According to the researches of Brooks, the embryo of the *Ostrea virginiana* shows also in its dorsal part a depression, which, however, according to his statement, contains the opening of the primitive intestinal canal—the blastopore. If one, however, compares Fig. 32 of his work with my Figs. 9, 10, and 12, I believe that it must be admitted as highly probable, that what Brooks has taken for the blastopore is nothing but the opening of the preconchylian gland. This view seems also to be confirmed by what he says of the origin of the shell, which actually begins to develop at the very point where the supposed blastopore is found. An

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[23] *Entwicklung der Tellerschnecke.* Morpholog. Jahrbuch, vol. v, p. 601.

[24] *Études sur le développement des Mollusques. Archiv. de Zoologie Expérim.*, vol. iv, p. 186.

[25] See his work quoted above, p. 6.

[26] *Ueber die Entwicklungsgeschichte von Teredo.* Arb. Zool. Inst., Vienna, vol. iii.

analogous development of the shell in the lamellibranchiates has, so far, only been discovered by Mr. Rabl[27] in the *Unio*, and is so utterly different from the observations relative to the development of other mollusks that competent authorities have already demanded a full verification of the facts.

To return to the embryo represented in Fig. 10, we find that the entodermal area, which in a previous stage showed only a slight depression, has become a deep invagination with a tubular cavity, a genuine *protogastrea*. Behind the mouth there are found a couple of large cells, which may probably be considered as the first cells of the mesoderm, although the manner in which they originate, and the subsequent development of the mesoderm, have escaped my observation. However this may be, one finds in the embryo on the following day (Fig. 12) mesodermic cells on the upper portion of the intestinal mass. The portion on the ventral side, located below the mouth, now begins to protrude very strongly, so as to form a sort of foot which causes the embryo to resemble a young gasteropod. The blastopore continues to be very distinct, and presents a somewhat triangular form. As far as I could ascertain, it did not disappear, but remains and is transformed into the mouth or rather into the cardia. For in the same way as in embryos where the blastopore closes, the esophagus and the mouth are formed by an invagination of the ectoderm; thus in embryos where the blastopore remains, there are ectodermic cells which take a part in the formation of the upper portion of the intestinal canal.

Great changes, both internal and external, take place during the further growth of the embryo; the preconchylian gland gradually loses its primitive character of a glandular invagination, and it reassumes its primitive character and forms a thickening of the ectoderm, composed of long conical cells (Fig. 13, *sk*). A thin cuticular membrane (*s*), produced by secretion from these cells, is the first indication of the shell. As at this point the hinge is found in the grown oyster, the description of Davaine, "a transparent streak * * * this is the first indication of the hinge," is perfectly correct. The bivalve shell of the oyster, therefore, originates in a single piece, and contrary to the observations of De Lacaze-Duthiers, according to which the two valves are produced "by two thickenings of the epiblast," which are supposed afterwards to unite and form the hinge. Brooks also states that the shell of the American oyster is from the very beginning composed of two valves, which develop from a small, irregular, and transparent organ located on each side of the dorsal furrow (his blastopore).

If we call to mind the fact, already referred to, that the true nature of this furrow and the real blastopore have escaped the observation of the American naturalist, we are certainly justified in doubting the correctness of his observation.

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[27] *Ueber die Entwicklungsgeschichte der Malermuschel*, in Jen. Zeitschr., ix, 1875.

On the contrary, the description given by Mr. Hatschek of the origin of the shell of the *Teredo* agrees perfectly with what I have observed in the *Ostrea;* and I think we are justified in considering as certain *that the shells of all mollusks originate in the same manner.* This is, doubtless, as the last-mentioned naturalist justly remarks, a very important argument in favor of the theory of the monophyletic descent of the mollusks, a theory which has been violently attacked by Von Jhering.

Meanwhile the ectoderm has become detached from the entoderm along the entire circumference of the embryo, so that for the first time a peritoneal cavity may be observed; a crown of vibratile cilia has developed above the mouth, and the surface of the velum is covered by deep cylindrical cells (Fig. 13). The entoderm has also grown considerably, and is now composed of a spacious stomach cavity, below which there is a diverticulum, still temporarily closed, but which later will communicate with the ectoderm and form the posterior part of the alimentary canal.

On the following day (Fig. 14) the shell, which has grown very much, covers a large portion of the body; it already contains carbonate of lime, as is shown when treated by acids. After steeping it for some time in acetic acid nothing remains but a thin membrane of conchyoline. The ectodermic cells, which are found on the surface of the shell, have become very thin and transparent, so that the outlines cannot be distinguished, but only the refringent nuclei. The larva (Fig. 15) takes food continually, moves about in a lively manner in all directions, and grows considerably. The velum now forms a very distinct part of the body, which is almost entirely covered by the shell. The surface of the velum, surrounded by a wreath of vibratile cilia, already shows in its center a thickening which is the beginning of the cephalic disk. An esophagus, in the shape of a funnel, leads to a large pear-shaped stomach, communicating with the outside through the intermediation of an intestinal canal.

Owing to the development of pigment at several points on the body (as on the cephalic surface, esophagus, gastric pouch, &c.), the larvæ gradually acquire a gray or bluish color. The shell now (Fig. 16) measures 0.16 millimeter in height. Its form is almost round, except the hinge, which is straight. During this period it is already furnished with small teeth, as De Lacaze-Duthiers has observed. From time to time the body of the larva may be observed to be withdrawn entirely into the shell. This is done by means of a dorsal muscle (*ds*) and a ventral muscle (*vs*) originating on the edge of the hinge in a ramified extremity, while their other extremities are inserted into the lower part of the velum. These muscles originate from mesodermic cells which, with their ramifications, cross the internal cavity of the body at several points; some of these cells which cross the dorsal part, from the left to the right valve, are gathered in a group, and form the adductor

(*sp*). When the larva moves freely, the part of the body which is in front of the mouth is thrust entirely out of the shell, and is partly folded. The vibratile zone in front of the mouth is composed of a double row of long cilia. If the surface of the velum (Fig. 17) is observed from above, it will be seen that these cilia grow on two rows of cells, placed close by the side of each other and of almost rectangular shape. From each of these cells there arise two vibratile cilia, whose course may be followed into the cellular protoplasm in the colored parts. I have not been able to discover a vibratile zone in the posterior part, although the portion of the head situated below the vibratile zone of that part of the body which lies in front of the mouth is provided with short vibratile cilia. The greater part of the surface of the velum is at this period covered with a single layer of cells, exceedingly small, so that they can be distinguished only by the place occupied by their stained nuclei. Only in the middle an enlargement may be noticed, having a considerable depression toward the interior and composed of several layers of ectodermic cells (Figs. 16 and 17, *kp*). This is the cephalic plate of which we have already made mention, whence originates the superior esophagean ganglion. Its surface seems to be divided into two parts by a transverse furrow. I have not been able to observe the peripheric nerves, issuing from the cephalic plate, which Hatschek has observed in the larva of the *Teredo*. This enlargement of the ectoderm seems to have been observed in the larva of the oyster by Davaine and De Lacaze-Duthiers; but both of them at first took it for the mouth opening—an error which was afterwards recognized as such by the last-mentioned of these two observers.

The intestinal canal is also strongly developed, simultaneously with the other parts of the body. The esophagus, covered with a brownish pigment, has become elongated, and in its upper part has become widened into a funnel. The gastric cavity, greatly enlarged, is by an annular enlargement divided into an upper and lower part; in the upper part there has been formed, to the right and to the left, a large round pouch (*l*), the beginning of the liver, while the intestine begins near the narrow part of the annular enlargement, and is folded in a loop on the left side of the body, before opening into the mantle cavity. The entire inner surface of the intestinal canal is lined with a vibratile epithelium, except perhaps the pouches of the liver, the inner portion of which is difficult to observe, owing to the great quantity of black pigment.[28]

The larva represented in Fig. 16 is the most advanced phase of free larvæ which we have observed; this had been taken from the mantle cavity of the mother oyster, or had been ejected by it when placed in

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[28] These are the hepatic pouches, of dark color, which form the black spot by which at an early stage in its development the oyster may be distinguished with the naked eye. This spot is generally considered by fishermen as indicating the beginning of the hinge.

an aquarium. I am not able to say anything positive in regard to the duration of the period which elapses from the time when the larvæ become free to the time when they become fixed; nor do I know what changes they undergo during this period. We have not succeeded either in producing a further development of the oyster larvæ, nor in securing their fixation, even in aquariums where there was a constant current of sea-water, or in those through which a continuous current of air was passing.[29] I have also been disappointed in my attempts to procure oysters in these phases of development by means of catching larvæ floating about in the sea. Although I have several times fished in the neighborhood of places containing collectors, by means of a trawl net, and obtained many different larvæ of annelides, crustaceans, ascidians, &c., I only once succeeded in capturing some oyster larvæ, although they doubtless move about freely in the sea for several days. We must consider the account of Engineer B. de la Grye[30] as fabulous, as he states that an oyster cultivator of the river Auray, after having squeezed the spawn from an oyster, smeared it on a stone which he immediately threw into the water, which stone soon became covered with oysters.

If one compares the most highly developed larvæ, described above, and the youngest among those which have become fixed, great differences in their organization may be observed. At first the shell grows very rapidly, for while it only measures 0.16 millimeter in height in a larva which is on the point of leaving the mother oyster, it measures more than 0.24 millimeter in the smallest of the fixed shells. The adductor occupies another place in the larva than in the fixed animal,[31] while in the fixed animal this muscle is found on the mouth side of the intestine, and therefore in the place of the posterior adductor of the *Dimyaria*, in the larva it is found in the ab-oral region (the hemal side, of Huxley) of the esophagus, or in the position of the anterior adductor of the *Dimyaria*. It is, therefore, probable that the adductor of the larva is homologous with the anterior adductor of the *Dimyaria*. The velum also disappears during this period, while on the other hand the branchiæ may be observed to grow. As shown by the drawing of a larva in a later phase of development (Fig. 19), the branchiæ are at first formed by filaments which are separate along their entire length, except at their bases and at their tips, where they are joined to each other. The branchiæ of *Ostrea edulis*, therefore, develop as De Lacaze-Duthiers also supposed,[32] in the same manner as those of the *Mytilus*

[29] These experiments were made in conjunction with Dr Leo de Leeuw. In order to pass air through the water, I used the apparatus recommended by Mr. Fol for journeys. This apparatus is composed of two petroleum cans (tin), provided at the top and bottom with a spigot, and joined by a rubber tube. One of the cans, filled with water, is placed at a certain height; from it the water runs into the lower can, drives the air out of it, and causes it to pass through the aquarium.

[30] H. de la Blanchère: *Industrie des Eaux*, p. 150.

[31] Professor Huxley called my attention to this fact in a letter to me.

[32] *Mémoire sur le développement de branchies.* In *Ann. des Sc. Nat.* 4me *sér. Zoologie*, vol. v, p. 43.

edulis. We therefore find in this fact another proof that, phylogenetically, the filamentous branchiæ represent a former stage, and the lamellar branchiæ a later one.

A no less important question is to ascertain how the oyster becomes fixed. It is known that some bivalve mollusks are fixed during their entire life by means of the byssus; others, on the contrary, like *Hinnites*, the *Spondylus*, &c., use this means only temporarily; and later their shell is firmly soldered to the object on which they are found. As the oyster becomes fixed at an early age, it becomes necessary to place the animal with the object to which it adheres (in short, the "collector") under the microscope, care being taken that it remains intact.

Mr. Ryder,[33] in "An account of Experiments in Oyster-culture, &c.," recommends to obtain for this purpose larvæ attached to cotton threads or to pieces of mica or glass. There is no doubt that among the substances mentioned by him glass will be the only one by which the object in view can be reached; for if the collector is opaque, microscopic observations by means of transmitted light become impossible and may prove the cause of great difficulties. I conceived the idea of using as collectors the glass slides used for mounting microscopic objects, and I was confirmed in this idea after having read an article by Prof. Karl Möbius in the *Zoologischer Anzeiger* of January 22, 1883. In order to procure living animalculæ for his microscopic observations he placed the glass slides in a wooden frame, which he put in the water about two feet above the bottom of the sea. A number of animalcules, such as *Polyps*, *Hydroids*, *Bryozoans*, *Infusoria*, &c., adhered to the slides so supported.

The apparatus used by me, which has worked very successfully, is composed of a series of wooden frames or bars, on the upper and lower edges of which a double row of small notches is cut, and in each of which a piece of a glass slide may be inserted. The central bar is provided with lateral notches, which makes it easy to take out the slides, while on the outer side a little peg holds it in place. On the lower side of the frame there is an iron band, which makes the apparatus heavier and prevents it from floating, while on the lower side of the upper edge there is a projection, which makes it possible to rest the collector on some support, so that a current of water may pass underneath. It was my intention to place this collector among the tiles used in the Netherlands for gathering the spawn of the oyster, so as to make my observations as much as possible under the same natural conditions.

The length of the collector is 210 millimeters [about $8\frac{1}{4}$ inches]—that is, almost the length of a tile—while its breadth is 180 millimeters [about 7 inches], so that on each side of the frame there may be placed six glass object-holders (English size). As it was to be feared that the larvæ would not adhere to common glass on account of its being smooth, some of the pieces of glass were ground rough; others were covered

[33] Report of Ferguson, Commissioner of Fisheries of Maryland, 1881, p. 57.

with a thin layer of hydraulic cement, which is generally used in covering the tiles. The result was that the apparatus answered its purpose admirably. The slides were left in the water 72 hours, and several larvæ became attached to them. Most of them were on the pieces of glass covered with lime, some on the rough glass, and only two on the common glass.

Microscopic examination shows that, during this period, the larva of the oyster is fixed on the collectors almost vertically, so that the hinge is at the top, and turned toward the observer (Fig. 18). The shells, which measures 0.24 millimeter in height, has still a homogeneous structure in the larva; and there may still be seen distinctly the little teeth at the hinge, traced in a straight line. Later these characteristics disappear more and more (Fig. 19) because the valves of the shell grow over or overhang the edge of the hinge, so as to form a swelling (*umbo*). The opinion of Mr. Ryder[34] that the hinge has no teeth, contrary to the observations of De Lacaze-Duthiers, may be true as far as the American oyster is concerned, but it does not apply to the *Ostrea edulis*, as I have stated above. There is deposited, all along the edge of the shell of the larva which is about to become fixed, a straight band of new shell substance, 0.012 millimeter broad, which shows the structure of the grown or secondary shell. This little band of secondary shell substance, which is naturally secreted in a liquid state along the edge of the mantle, may possibly have aided the little oyster in adhering to the piece of glass. I regret that I am unable to solve this problem satisfactorily. I believe that I have repeatedly and very distinctly noticed a small byssus; but the difficulties encountered in these investigations are so numerous that, like Mr. Ryder,[35] I have not been able to arrive at a definite result.

In the first place the almost vertical position of the little shell is very unfavorable to these investigations; moreover, the larva but rarely adheres to smooth glass, and is certain to do this only on glass covered with lime. In order therefore to observe the small object with transmitted light it becomes necessary to remove the lime, in which I succeeded pretty well; for after the slide has been held for 5 or 10 minutes in a solution of 1 per cent chromic acid, all the carbonate of lime has disappeared. By this treatment the carbonate of lime of the shell has of course also been dissolved, which causes the young oyster to undergo such modifications in its appearance, that this method has not been of any assistance to me. If one takes into consideration also the circumstance that all sorts of animalcules adhere to the young oyster and all around it (such as *Vorticella*, *Acinetians*, &c.); and that all kinds of impurities adhere to it, which cannot be removed by mechanical means without injuring the young oyster, it will be acknowledged that it is exceedingly difficult to ascertain whether or not there is a thin filamentous byssus.

[34] Bulletin of the United States Fish Commission, 1882, p. 384.

[35] See the preceding note.

The existence of such a filament, however, seems very probable to me. This byssus would therefore serve, as in the *Hinnites*, as a temporary means of adhesion, and would soon give place to new shelly matter, which is deposited along the edge of the shell, and which, while forming, solders the larva to the collector. If no trace of a byssus is found in the grown oyster this is not a serious argument against its existence in the larva, for it is not found in grown specimens of *Unio* and *Anodonta*, which have a byssus in the larval state.[36]

If one examines the structure of the secondary shell of a small oyster which has been fixed for some days, it will be seen that it is not composed of homogeneous layers as in the larva; but that it presents a reticular structure, and is composed of small prismatic columns of lime, separated from each other by an organic substance (conchyoline) (Figs. 19 and 20). The diameter of one of these columns is about 0.012 millimeter. They are of a granulous character, as if they had been formed of small globules, one resting upon the other. These prisms, however, are not formed at the extreme edge, *i. e.*, in the most recent portion of the shell, where nothing is seen but a network of conchyoline, whose meshes are not yet filled (Fig. 20).

As is well known, the outer portion of the shell of the grown oyster, of the *Margaritana* and others, also presents a prismatic structure. If in the *Margaritana* the lime is removed from these prisms, nothing remains but the walls around the columns, which seem to be composed only of organic matter, and a small and insignificant organic remnant of the prisms.[37] According to Hessling, these layers are formed by a deposit of carbonate of lime in the prismatic cavities of the numerous thin layers of conchyoline.[38] The empty meshes which I have described above, and which are formed at the extreme edge of the little oyster shell, as well as the observations made by Tullberg on the shells of the *Margaritana*, speak strongly in favor of this opinion. The dark lines seen in Fig. 19 inside the shell seem to me to be nothing else but filaments of conchyoline; at least in breaking the shell of a small living oyster, I saw numerous gelatinous filaments between the mantle and the extreme edge of the shell.[39]

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[36] As, according to the observations of Bouchon-Brandely, the Portuguese oyster, which is unisexual and whose eggs can therefore be fecundated artificially, adheres to some object a couple of days after fecundation has taken place, I had hoped to be able to have a better chance of studying its mode of fixation. Through the kindness of Mr. Tripota, of Vernon, I received about 50 specimens of this oyster, but the unfavorable weather which we had during the month of July was probably the cause that the larvæ, although theybegan to develop, did not adhere to any object.

[37] Tycho Tullberg: *Studien über Bau und Wachsthum des Hummerpanzers und der Molluskenschalen*, in *Kongl. Svensk. Vetsk. Acad. Abh.*, vol. 19, 1882.

[38] Th. von Hessling: *Die Perlmuscheln*, 1859, p. 260, vol. v, Fig. 3.

[39] This report was already in the press when I came across an article by Mr. Osborn: "On the structure and growth of the oyster shell" (Studies from the Biological Laboratory, Johns Hopkins University, vol. ii, No. 4). By the advice of Dr. Brooks, Mr. Osborn studied the formation of the oyster shell, by boring in the edge of the

It is remarkable that the lower valve does not show the reticular design of the upper valve, but undulating striæ and points joined closely to each other (Fig. 21); this different appearance of the two valves seems to be due solely to the circumstance, that the calcareous particles of the lower valve do not have the regular prismatic structure which they assume in the upper valve, and that they are smaller and of irregular shape. This difference of structure can be traced more or less distinctly throughout the entire life of the oyster; for while the upper valve has a linear structure and is composed of layers which do not adhere very firmly to each other and where the prismatic tendency can immediately be recognized, the lower valve, on the contrary, presents a denser appearance and seems to be composed of layers closely joined to each other.

As regards the difficulty of recognizing the young oyster soon after its fixation, I think that I have overcome it by using a tile covered simply with hydraulic cement, instead of a mixture of lime and sand. The numerous small uneven places caused by the grains of sand make it difficult to see the young oyster shell on the collector, even to the experienced eye of the oyster cultivator. In order to get as even a surface as possible, I used a glass tile instead of a common tile; but I do not consider this absolutely necessary. After this tile remained in the current for eight days, some small oysters became attached to it, the largest of which measured 0.85 millimeter and the smallest only 0.57 millmeter in height; and still even these latter could be distinguished by the naked eye.

I must, in conclusion, say a few words in regard to a probable enemy of the oyster. I had in my aquarium a mother oyster which from time to time ejected large numbers of larvæ. There were in the same aquarium two *Actiniæ*, such as are found in large quantities on the shell of of the oyster. I found that the larvæ diminished rapidly; and in endeavoring to ascertain the cause I found floating in the water a certain number of small bluish balls, about 2 millimeters in diameter; and at the same time I saw a similar ball issue from the mouth aperture of an *Actinia*. In examining these small balls under the microscope I discovered that they were composed of empty oyster shells pressed closely against each other, and that in fact they were the remnants of the repast of the *Actinia*. Although I do not think that, under ordinary conditions, the *Actiniæ* can easily seize the larvæ, they might nevertheless destroy a large number, if they multiplied to any great extent among the oyster parcs.

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shell holes which were temporarily closed by means of thin pieces of glass, on which the conchyoline could be deposited. Mr. Osborn arrived at the conclusion that the shell is formed by the crystallization of carbonate of lime in the chitinous membrane. The opinion of Hessling (with whose researches Mr. Osborn does not seem to be acquainted) that the carbonate of lime is deposited in the prismatic cavities, does not, according to Mr. Osborn, seem to be borne out by the facts.

EXPLANATION OF THE PLATES.

FIG. 1. Egg of the oyster, with the germinal vesicle and spot visible within the vitellus.

FIG. 2. Beginning of development; the germinal vesicle has become invisible, and the polar globules make their appearance.

FIG. 3. First stage of segmentation; the egg is divided into two spheres of unequal size (animal sphere and vegetative sphere).

FIG. 4. More advanced stage, the egg being divided into four spherules.

FIG. 5. Stage of development where the egg shows one large vegetative sphere and several animal spheres.

FIG. 6. More advanced stage, seen from above, where the vegetative sphere is divided into two spherules.

FIG. 7. Embryo, side view, at the beginning of invagination (*gastrula*).

FIG. 8. Embryo more developed, optic section, with invagination of the entoderm and beginning of the preconchylian gland; *ec*, ectoderm; *en*, entoderm; *o*, blastopore; *sk*, preconchylian gland.

FIG. 9. Embryo a little older, side view; *v*, pediform appendix; the other letters as in preceding figure.

FIG. 10. Same stage, optic section; *me*, mesoderm; *d*, primary intestine.

FIG. 11. Embryo a day older, front view, with the primary mouth opening.

FIG. 12. The same embryo, optic section.

FIG. 13. Embryo a day older, with a wreath of vibratile cilia, a stomachic cavity, and a beginning of a shell, *s*.

FIG. 14. More advanced stage, side view, with shell more developed.

FIG. 15. Larva still more developed, with velum, and the beginning of the cephalic plate (*scheitelplatte*); *a*, anus; *e*, intestine; *m*, stomach; *sl*, esophagus; *kp*, cephalic plate.

FIG. 16. Larva a little older, with a double pre-oral wreath of vibratile cilia, a cephalic plate, hepatic pouch, and muscles; *ds*, longitudinal dorsal muscle; *vs*, longitudinal ventral muscle; *sp*, adductor muscle; *l*, hepatic pouch; *mh*, mantle cavity; the other letters as above.

FIG. 17. The velum or rotary disk, with the double row of ciliated cells, seen obliquely from above.

FIG. 18. Larva as it attaches itself, in an almost vertical position.

FIG. 19. Little oyster, about 7 days old; the height of the primary homogeneous shell is 0.24 millimeter, that of the secondary part, composed of prisms, is 0.15 millimeter; the beginning of the branchiæ and the adductor muscle are visible.

FIG. 20. Fragment of the edge of the preceding shell, to show how the calcareous prisms are formed.

FIG. 21. Fragment of the lower valve.

Fig. 1.

Fig. 2

Fig. 3.

Fig. 4

Fig. 8.

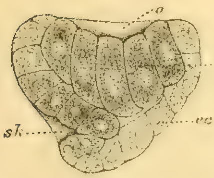

Fig 9.

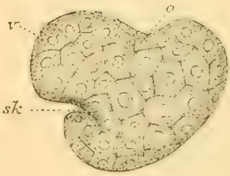

Fig. 10

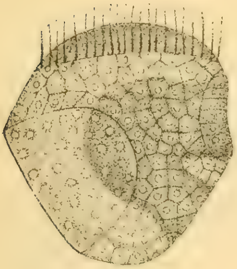

Fig. 14

Fig 15.

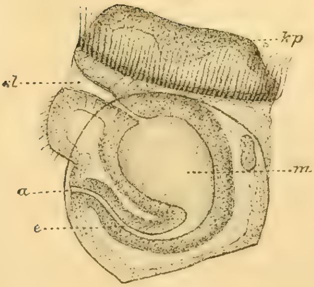

Fig. 16.

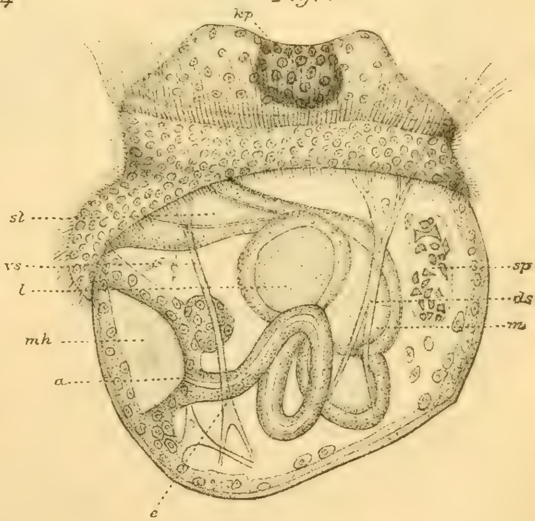

PLATE II.

Fig 5.

Fig. 6.

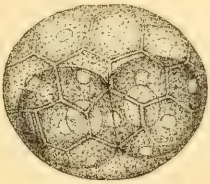

Fig. 7.

Fig. 11.

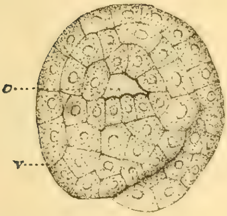

Fig. 12.

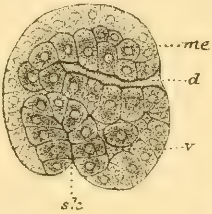

Fig. 13.

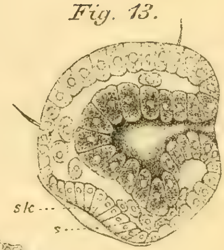

Fig 17

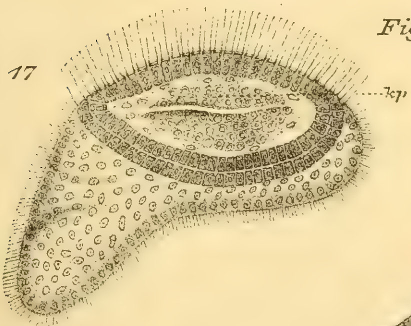

Fig. 20.

Fig 21.

Fig. 19.

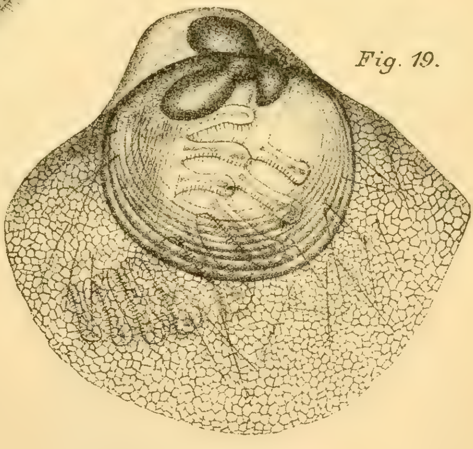

Fig. 18.

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XXXV.—OYSTER-CULTURE AS SEEN AT THE LONDON FISHERIES EXHIBITION.*

By S. A. Buch.

Judging from the great importance of oyster-culture, a much larger number of exhibitors was looked for. The countries which were well represented were England, Holland, America, and Spain. France had remarkably few exhibitors.

In speaking of apparatus used in oyster-culture and in the oyster fisheries I shall have special regard to those which might possibly be introduced in Norway and which are adapted to our circumstances.

Among the English exhibitors the Whitstable Oyster Company deserves special mention, as it exhibited a complete and very instructive collection of everything relating to the oyster fisheries on the company's beds. In Whitstable, a small town on the south bank of the Thames, this trade is of very ancient date, and the company referred to acquired the full ownership of these beds by an act of Parliament as early as 1763, and had even carried on these fisheries for some time previous to that date. These oyster-beds are always under water, and are of considerable extent. The gathering of young oysters on artificial collectors is not carried on here; but those young oysters which have been deposited on natural objects outside the oyster-beds, as on stones, oyster-shells, &c., are collected by means of bottom-scrapers, sorted, and planted on beds outside the town. The limits of the beds are carefully defined, and are constantly guarded by three or four watch-ships, which lie at anchor on different parts of the banks. This gathering of young oysters is carried on all the year round by about one hundred small vessels on those banks where the oyster fisheries are free. These vessels are not owned by the company, but belong to different persons, some of whom are shareholders. The young oysters are sold to the company, which plants them on the banks mentioned above, of which it is the sole owner.

As the consumption of oysters during the last few years has increased so much that it was found impossible to satisfy the demand in the manner described above, the company has for several years imported millions of French oysters, which are raised on the Whitstable banks, and

* "*Osterskultur.*" From *Norsk Fiskeritidende*, vol. iii, Nos. 3 and 4, Bergen, October, 1884. Translated from the Danish by Herman Jacobson.

are sold when they are three or four years old. The oysters which are to be sold are taken from the beds with bottom-scrapers by the so-called dredgers, and are sorted on board. Those which are too young for the market are, of course, again placed in the water; and as the beds are arranged in such a manner as to have oysters of different ages separate, young oysters can very easily be taken up and planted, which aids the work considerably.

Besides models of vessels, bottom-scrapers, and other apparatus, the company also exhibited a very fine collection of oysters of different ages, of sponges and algæ found on the beds, and of various enemies of the oyster. As the oyster fisheries with us are carried on in a very different manner from what they are in England, and as our fisheries will, owing to the different nature of the bottom, hardly undergo any change in the near future, a description of the apparatus exhibited by the Whitstable Company will scarcely be of interest to the Norwegian public.

Lord Scott, the owner of beds and basins for young oysters on the Isle of Wight, exhibited models of two basins. They were both dug out of the ground and surrounded by strong embankments, held together by piles and wicker-work, clay and stones being placed between the layers of wicker-work. The inside of the basin is lined with birch branches. They are connected with the sea by a pipe having a knee, which when the tide is out is turned aside, so as to receive the superfluous water and carry it out into the sea, whenever it is desirable to change the depth of water. It is said that experience has taught that in this manner the water is easily renewed without occasioning any considerable loss of young oysters. On account of the heavy swell on the English coast, the basin is filled in the same manner, when the tide comes in, simply by bending the pipe in one or the other direction.

One of the basins occupies an area of three-fourths of an acre and the other 1 acre. Their depth varies from 4 to 6 feet. When the water is low, both basins can be emptied completely. These basins are used exclusively for gathering young oysters. Near to them are the beds which are used both for keeping and fattening the mother oysters and for raising young oysters.

Towards the end of May there are gathered from the beds and planted in the basins a suitable number (generally from 15,000 to 20,000) of mother oysters. They are laid on the bottom, between the scaffolding of laths on which the collectors are placed. The scaffolding is 30 centimeters high [about 12 inches], 1 centimeter broad [about four-tenths inch], and of the same length as the basin. It rests on the bottom, and on it are placed laths, on which the bricks are laid. The bricks used here are generally flat, it being asserted that the oysters can more easily be taken off than from the long and bent bricks used at Arcachon. Before the bricks are laid on the scaffolding they are dipped in a mixture composed of eight parts sand and two parts lime. In this mixture

they are dipped thoroughly, so that the lime is evenly distributed, and the brick is then dried in the sun for several days. As sand from fresh water frequently contains clay, which would be apt to make the surface of the collector slimy, sea-sand is used exclusively. This covering of lime is put on the brick, so that the young oysters can more easily be removed from it. I have heard it stated that the brick is covered with cement, but as far as England and Holland are concerned this is a mistake.

When the collectors are set out, in June, there is only just enough water in the basin to cover the mother oysters, but after all of the collectors have been put in position the basin is again filled to its edge. The collectors remain in the basin till September, when they are taken up and placed in open boxes, which are sunk out in the sea, in water deep enough to secure the young oysters against injury from ice and heavy waves. At the same time the mother oysters are taken from the basin and placed on the beds; this finishes the work of the year in the basins. In May, the collectors, covered with young oysters, are taken out of the boxes, and the oysters are removed from the collectors, sorted, and placed in low, floating wooden boxes, with lids and bottoms of galvanized-iron wire. The oysters are not put on the beds until they have reached the size of 3 centimeters. The bricks which have served as collectors are dried and dipped anew in the lime mixture referred to above, and can thus be used for many years.

In Lord Scott's basins, during the short time they have been worked, there were produced—

Years.	Number of young oysters.
1880	25,000
1881	300,000
1882	1,500,000

Besides models of these basins, Lord Scott exhibited a number of the apparatus used by him, such as tongs for holding the bricks while they are dipped in the lime mixture; a wooden funnel, 1 or 1.25 meters high, used in removing the young oysters from the collectors; knives, with semicircular blades, employed in this process, &c.

G. Dillnot, of North Hayling, England, placed on exhibition collectors made of sackcloth extended on a framework and covered with a lime mixture; and also "hospitals," whose sides consisted of perforated boards, 15 centimeters broad, with a bottom of wire netting and a lid of sackcloth, being 2 meters long and 1 meter wide.

From the large Essex oyster-beds exceptionally fine oysters were placed on exhibition. These beds have a stone bottom covered with oyster-shells, where the young oysters are deposited. By a quick blow on the stone or the shell to which the oyster adheres it is separated

from the collector. These beds supply a great many fattening beds along the coast with young oysters.

Percy H. Russ, of Sligo, Ireland, who owns fattening beds near Culleenamore, Cullenduff, and Lufferton, exhibited Arcachon oysters which he had fattened on his beds. As his attempts to gather young oysters had failed, he now confines himself exclusively to the fattening of French oysters. The months of March and April are said to be the most favorable for transplanting oysters from the French beds. Four-year-old French oysters fattened on Irish beds were sold this year at 14 shillings per 120 oysters, or about $2.83 per hundred.

Several English oyster-dealers exhibited American and Portuguese oysters (*Ostrea angulata*). These oysters, however, are but little sought either in the English or the continental markets, and it would therefore be folly to stock waters which have no oysters with these inferior varieties. Some in this country have spoken in favor of the American oysters, but as a general rule they are not liked. There is, however, reasonable hope that our own beds will soon be able to furnish all the oysters needed for stocking our waters. If, nevertheless, it should be deemed necessary to import mother oysters, it seems to me that they should be imported from Holland or France, in order to make a practical test as to how these oysters will flourish in our waters and climate.

The French department was not very well represented. Alphonse Martin, of Auray, placed on exhibition oysters in different stages of development, and also some apparatus used in oyster-culture, the following of which deserves special mention:

1. A collector made of boards. It consists of ten shelves, arranged one above the other. Each shelf consists of ten boards, 7 or 8 centimeters broad and 1 centimeter thick. The distance between the shelves is 5 centimeters. At both ends the collector is inclosed by a belt of thin laths, whose prolongation forms the four legs of the collector. When the collector is full, and the young oysters are to be taken off, the belt is loosened and the shelves come apart. The entire collector is covered with a mixture of lime and sand. This collector is expensive, but deserves to be recommended, because on its different shelves it will gather a large number of young oysters. It can easily be kept clean, as the light falls only on the upper shelf, where a vegetation of confervæ will principally be found.

2. A "hospital" for young oysters, resembling a common bed, with bottom and lid of galvanized-iron wire and wooden sides. The lid is fastened to the frame by wooden pegs which pass through the prolongation of the legs. Formerly floating "hospitals" were often used, while now they are generally placed at the bottom, to which they are held fast by four rectangular iron hooks, one of which spans each corner of the "hospital."

3. A trough-shaped sieve of tin, 10 centimeters deep, 50 broad, and

60 long, with two handles and twelve holes, each hole being 6 centimeters in diameter. This apparatus is used in sorting oysters.

4. A hollow spade of peculiar shape, used for spreading the oysters over the beds. This is a very practical instrument, and deserves to be introduced in Norway.

The same firm also exhibited tongs used for dipping the bricks, knives for scraping off the young oysters, and a number of the peculiar wooden shoes used extensively in France by persons engaged in oyster-culture. Owing to the soft bottom of the oyster-beds, these shoes have under the sole a contrivance shaped like a trough, longer and broader than the shoe itself.

Another French exhibitor showed live oysters in different stages of development, and also boards from the above-mentioned shelf collector thickly covered with young oysters. The one year's oysters measured 2 or 3 centimeters in diameter, two years' 5 or 6, and three years' 8 or 9.

Spain made an exhibit of a fine collection of different kinds of oysters. Those from Rio Santa Marta bore a striking resemblance to our deep-water oysters from Ostravig. The oysters from Ferrol and those from Galicia had a very uneven shape, while some young oysters that adhered to tiles and willow branches were particularly well-shaped. The oysters from Rio de Zumaya had a stronger and finer appearance and a better shape than those previously mentioned, and were of the grayish-violet color peculiar to our Norwegian oysters.

In 1877 the Government established some model oyster beds on the Rio Santa Marta. The young oysters are brought from Arcachon, and thus far the experiments have been exceedingly successful. Several private individuals have also established oyster-beds, especially near Marta di Ostigneira, and as there are in these waters very few radiates, which are the worst enemy of the oyster, everything promises well for the success of these establishments.

From the north coast of Cuba there were sent oysters of a long, deep shape, resembling the American oysters, 8 or 9 centimeters long and 4 or 5 centimeters broad. The inside edge of the shell was of a violet color. All these oysters adhered to branches with a thick bark which had been laid on natural beds.

The Americans exhibited oysters and the various implements used in the American oyster-trade, but as they are not of special interest to our oyster-culturists we pass them by. China, Peru, and Australia exhibited merely specimens of oyster-shells, and oysters put up in hermetically sealed cans.

The best collection in this department came from Holland. The Dutch oyster-culturists, under the name of "*Maatschappij tot bevordering der Oestercultuur*, Bergen-op-Zoom" (Society for Promoting Oyster Culture, Berg-op Zoom, Netherlands, exhibited everything relating to oyster-culture, from excellent models of Dutch oyster parcs to small implements. For collectors the Dutch generally use tiles, treated in all es-

sential points as in England; also long, curved tiles like the French, 40 centimeters long, 15 centimeters broad, and 8 centimeters thick. A third collector, of a new construction, consisted of two iron frames, 2 meters long and 80 centimeters broad, placed against each other so as to form a roof. Each frame is filled with iron wires running parallel with each other, and on these wires there are strung brick beads 3 centimeters long and 1.5 centimeters in diameter. The principal advantage of these collectors consists in the fact that these beads, after the young oysters adhere to them, can easily be taken off the wires. As the oysters remain on the beads during the entire period of their development, much tedious work is avoided which is otherwise connected with the removal of the young oysters from the bricks or tiles. I am of opinion, however, that this collector is both too expensive and on the whole not very practical. As it is comparatively new, it has not yet been very generally introduced in Holland, and will scarcely meet with general favor, as the oysters developed on these beads will have a very singular shape.

All the "raising-boxes" were of the same system; generally 1.8 meters long, 0.9 meter broad, and 0.1 meter high; either entirely of steel wire (tarred or galvanized) or with a wooden frame and wire bottom and lid. These boxes are, strictly speaking, a French invention. In Holland they are used for the young oysters until they have reached a certain size, often till they are eighteen months old.

The bottom-scrapers exhibited by England and Holland were of the old, well-known form. As they show nothing new, and are not likely to come into use here, I shall pass them by. I must mention, however, an iron rake with long prongs, which will be very serviceable for taking up loose oysters in places where the bottom is so uneven that the scraper cannot be used. This rake is 50 centimeters broad, the prongs are 30 centimeters long and 1 centimeter thick, and the distance between the prongs is 4.5 centimeters. To the head of this rake there is attached a bag (size of the meshes 3 centimeters), intended to receive the oysters, which are taken off the bottom and fall into the bag between the prongs.

The scrapers which are used for cleaning the bricks after the young oysters have been removed look like a curved, flat pick-ax, the stem being 15 centimeters long and the blade 25 centimeters long and 6 or 7 centimeters broad. The Dutch knives and tongs resemble in all essential points the well-known English and French knives.

In connection with my visit to the exhibition I also paid a visit to the Dutch oyster establishments, which are now all located on the eastern branch of the Schelde. I was received with the greatest kindness by the public and private officials with whom I came in contact, especially Mr. A. A. W. Hubrecht, professor of zoology at the University of Utrecht, and I was thus enabled to study oyster-culture even in its most minute details.

Until the year 1870 the oyster fisheries in Holland were free; they were then carried on principally in the Zuyder Zee, and in the eastern and western branches of the Schelde. Fish of prey had reduced the stock of oysters to a minimum, so that it became evident that nature had to be aided if the oyster was not to disappear from the fauna of the Netherlands. During the same year a railroad dam was constructed between North Brabant and South Beveland, whereby the east and west branches of the Schelde were completely separated, the former being transformed into an immense salt-water basin, whose narrowest entrance is between Gorishoek and Ijersekendam. The basin is bounded on the north by Tholen, on the west and south by South Beveland, and on the east by North Brabant. The Dutch at once saw the great advantages of this basin for oyster-culture. With a view to assisting the oyster industry, all oyster-fishing was prohibited on the coast of Holland, which could easily be done, as the Government is the owner of the entire coast, and as a special license is necessary in order to use the beds and other localities suited to oyster-culture.

The basin of the Schelde is divided into about 300 square parts, which are rented out at public auction to the highest bidder for a period of fifteen years, the annual income from the rents of the entire basin amounting to 21,000 florins [$8,442]. Since that time oyster-culture has made very rapid progress, and is now exclusively concentrated around the east branch of the Schelde.

During the period from 1876 to 1882 there were exported from the Netherlands the following quantities of oysters:

Years.	Number of oysters.*
1876	36, 580, 000
1877	9, 679, 200
1878	7, 193, 200
1879	11, 116, 095
1880	16, 548, 918
1881	21, 844, 672
1882	15, 632, 450

* 1,200 oysters are generally calculated to make 84 kilograms.

These figures show great progress since 1877. The last year alone shows a decrease; but the reason for this must be sought in the circumstance that the oysters, from various causes, were much smaller than usual. The published reports state that during the year 1882, barrels intended to hold a thousand oysters held from 1,200 to 1,600. The average price during the last few years was 60 florins [$24.12] per thousand.

Already during the summer of 1884 the area which would become free in 1885 was sold at public auction. The portions were then rented out for the next five years, that is, until March 31, 1890. The new renters, however, have the privilege, under certain conditions, of renewing their

contracts after 1890, so that they may hold them until March 31, 1915. In future this area will yield the Government an annual revenue of 363,270 florins [$146,034.54].

This shows that the Dutch, in spite of the decrease in the oyster yield in 1882, are by no means discouraged, but that, on the contrary, there is the most lively competition for vacant portions, it being generally considered an exceedingly good investment. It should also be remembered that the Dutch, through an experience of fifteen years, have gained a very thorough knowledge of every portion of this area, and by their innate business tact and thrift have learned to appreciate its value and the excellence of the methods employed in oyster-culture. This also explains the enormous difference in the rents from 1870 to 1885. I may mention, by way of illustration, that the rent for lot No. 162 (12 acres) in 1870 was 1 florin [40.2 cents] per annum, while the rent paid at the last auction was 2,425 florins [$974.85]. In 1870 lot 163 (same size) rented for 1 florin; but from 1885 on the rent will be 2,725 florins [$1,105.45]. Lot No. 176 (same size) in 1870 rented for 270 florins, [$108.54], but at the last auction it was rented for 6,100 florins [$2,452.20]. Lot No. 138 (12 acres) rose in price from 222 florins [$89.24] in 1870 to 9,150 florins [$3,678.30] per annum. The rents for other lots have advanced or declined according to their value for oyster-culture as shown in the past.

The following table will show the sale of oysters during the different months of the year:

Months.	1881.	1882.
	Kilograms.	*Kilograms.*
January	151, 002	140, 372
February	273, 416	84, 098
March	453, 515	42, 098
April	85, 729	8, 114
May	38, 734	562
June	1, 118	....
July	....	....
August	1, 152	1, 670
September	61, 146	56, 934
October	72, 720	167, 929
November	125, 294	377, 441
December	183, 435	227, 907
	*1, 547, 331	†1, 107, 299

*Equals 21,844,672 oysters. †Equals 15,632,450 oysters.

In the year 1882 there were exported from the Netherlands to—

Countries.	Kilograms.
Belgium	189, 165
Germany	346, 333
England	571, 801

I visited the more important places on the Schelde, such as Tholen, Berg-op-Zoom, Ijerseke, Ijersekendam, and Wemeldinge, in order to

get a thorough knowledge of the Dutch oyster industry. The three last-mentioned places are villages in South Beveland, and have derived all their importance from the flourishing oyster industry, while the former two are old towns. The Beveland villages were formerly of no importance whatever, while now new and beautiful buildings are rising every year. Each house has its garden in front, and from poor fishermen people have become well-to-do house-owners. This is principally caused by the oyster industry, which furnishes regular and remunerative work to all members of the family.

All that the Government has to do with this industry is to appoint and maintain a superintendent, with a suitable staff of assistants and a number of vessels, enabling him to collect the rent and attend to similar duties. This superintendent has also to supervise the other fisheries (such as the mussel, anchovy, and eel fisheries) in the Schelde and the other streams in the province of Zealand for which some rent is paid. On the area rented by him the renter can make whatever arrangements he pleases. As a matter of fact, all arrange their fisheries in the same manner, that is to say, in the manner which has been found to be the most practical and remunerative, and which I will now briefly describe.

It is well known that the tide rises and falls several feet on the coast of the Netherlands, so that large portions of the Schelde basin are sometimes under water and sometimes dry. One would expect that a large quantity of young oysters would be carried out to sea by the current, but it has been proved by experience that the young oysters which are carried out by the tide are again brought back to the basin six hours later when the tide comes in. Each lot is marked by piles. Shallow lots are used for gathering young oysters and deep lots for fattening and raising oysters. Oyster-culturists, therefore, generally rent several lots, some deep and some shallow. Along the dikes which protect the coast of the Netherlands there are oyster parcs, some dug out and others surrounded with dikes and fascines. These parcs can be laid dry, and are used for storing the collectors full of young oysters during winter, so as to protect them against ice and frost, and for storing the so-called "hospitals," in which the young oysters are kept until they are large enough to be planted on the beds. They are also used as storehouses for those oysters which are kept for sale. Of these parcs there are two kinds, completely protected ones, and incompletely protected ones. In the former the sea never goes over the dike, but the necessary water is taken in through a sluice, while in the latter the dikes are so low that at high water the sea goes over them, the daily supply of water being thus furnished without the aid of sluices. The bottom and the lower part of the sides are generally of brick-work, and each parc is generally divided into several parts by brick partitions which also serve as rests for the boards which bear the "hospitals." These parcs are often of considerable extent; generally, however, their

area varies from 2 to 4 acres. At Wemeldinge very expensive excavations are being made at the present time for an enormous parc in the most fertile ground inside the dikes. Its bottom and sides are of brick laid in cement. The water will be supplied by two pumps, worked by steam, one of which will introduce fresh water into the basin, while the other will carry off the water. As the basin is subdivided by zigzag-shaped partitions, the water which is pumped in has to go through all parts of the basin before it flows out. This is in several respects an interesting experiment. The principal object is to become to some degree independent of the state, as it is supposed that this basin, besides receiving the collectors with young oysters, and the "hospitals," will also be used for fattening oysters, where they will remain until ready for the market.

The most striking objects in these Dutch oyster towns are the large quantities of bricks, some red and others covered with lime. In the course of the winter the bricks are burned in the numerous brick-kilns in the neighborhood, and during spring and far into June people are busy covering them with lime. It is very important that the lime should be perfectly dry before the bricks are laid on the beds. Last year from 15,000,000 to 16,000,000 of bricks were used as collectors in the basin of the Schelde, a single firm in Berg-op-Zoom alone using in 1882 1,200,000; and it is probable that at no very distant period bricks will be used exclusively for collectors.

In the Netherlands the bricks are covered with lime in the following manner: If the brick is new, it is first dipped into a thin lime mixture (CaO), so as to cover up the fine pores of the brick. When this cover is dry the brick is dipped in a mixture of one part lime (CaO), one part carbonated lime ($CaCO_3$), two parts sand, all of which is well stirred until it has the consistency of mush. As it is important that the cover should be as even and smooth as possible, both the lime and sand are sifted through fine sieves. The brick is then carefully dried in the sun.

In June and July there may be seen in the small Dutch towns whole fleets of flat-bottomed boats or small vessels taking in full cargoes of these bricks. At high water they sail into the lot for which they are destined. Here the bricks are thrown out helter-skelter, and as soon as the water is low they are arranged in regular rows. The bricks are placed on their edge, the long side downward, one close to the other; and as every brick runs to a point, there will be a space of from 1 to 2 centimeters between every two bricks. There is nothing to prevent several such rows of bricks being laid one on the top of the other. Formerly the bricks were laid with the flat side downward, one layer above the other, but the present method has been found to be more practical, as in this way the bricks are better protected against confervæ, sand, and impurities.

Where the water is so deep, even at low water, that the collectors cannot be arranged by hand, they are let down from the boats in small

piles, each containing about twenty bricks. In that case they are held together by a galvanized-iron wire, which is passed through a couple of holes in each brick and tied into a knot at the top, by means of which the bricks are laid and taken up again.

The collectors are left in the water till September, when the small vessels again come to the beds and remove them to the parcs, where they are kept during the winter. In April the young oysters are taken off the collectors by means of axes with a semi-circular blade, a small groove being made in the lime all round the oyster, which is removed by a pressure from the side. The young oysters are then placed in the so-called "hospitals," where they are kept until they have reached the length of 3 or 4 centimeters, when they are removed to the deeper beds, where they remain till they are ready for the market, generally for two or three years. In spite of the practical manner in which the Dutch manage all their business, and in spite of the utmost care, the official Dutch reports state that 80 per cent of the young oysters are lost before they have reached a salable size; 10 per cent are lost in the parcs, 40 per cent in the "hospitals," and 30 per cent on the beds. The oysters are taken from the beds by small vessels, by means of bottom-scrapers of the same shape as those used in England. During this operation a war of extermination is of course waged against all enemies of the oyster.

In the Netherlands science goes hand in hand with practice, and it must be acknowledged that the results of this co-operation are truly astonishing, and that in many respects it deserves to be imitated in other countries. The traveling zoological station, which this year was located at Tholen, has done a great work by solving many problems hitherto considered insolvable, and by correcting many errors. During my stay in the Netherlands five young, energetic Dutch scientists were engaged at this station, which is in operation all through the summer until September. I was received by these men with the greatest kindness, and was thus enabled to get an insight into the work performed at the station, and observe their scientific and practical experiments. This year's experiments were made with young oysters in inclosed basins. A firm in Tholen for this purpose placed a large parc at the disposal of the station. By a close board fence the parc had been divided into two parts. Mother oysters and collectors of every kind were placed in both, and in order to supply the water with the necessary amount of oxygen one division of the parc was furnished with a net-work of tin tubes, through which the water was impregnated with compressed air. Into the other division oxygen was introduced by means of long axles to which a number of shovels were attached, and which were constantly kept in rotary motion by a steam-engine. When I left the Netherlands no results had as yet been obtained, but I hope to be able to communicate some at some future time. The station is supplied with experimental aquariums, scientific instruments of every kind, and a large library.

APPENDIX D.

SCIENTIFIC INVESTIGATION.

XXXVI.—REPORT ON THE MEDUSÆ COLLECTED BY THE U. S. F. C. STEAMER ALBATROSS, IN THE REGION OF THE GULF STREAM, IN 1883–'84.*

By J. Walter Fewkes.

The wealth of marine life which peoples the surface waters of the Gulf Stream is in part made up of a rich and varied medusan fauna. This fauna has been but little investigated, considering the great number of genera which we have every reason to believe is embraced in it. Although in a general way we may conclude that many of the Northern European medusæ are carried there by the Gulf Stream, and are, therefore, identical with those of our own coasts, many others, particularly those found in warmer waters of Florida and off the Carolinas, do not make their way into these high latitudes. The Acalephs which have been collected from the eastern coasts of the United States are also, in part, inhabitants of the Gulf Stream. The jelly-fishes from New England undoubtedly have associated with these more southern medusæ many others which have been brought south from colder waters through the agency of counter currents setting from the north. The medusæ of the Gulf Stream include, in addition to those mentioned, many others, some of which are new to science; and it is the purpose of the present paper to gather together the scattered observations which have been made on animals of this group found in that part of the Gulf Stream adjacent to our eastern coasts as a contribution to our knowledge of this subject. This paper deals with medusæ known to inhabit the surface waters and those which have been ascribed to the depths of the sea. The majority of the animals which are here mentioned and described were collected by the U. S. Fish Commission steamer Albatross in the years 1883–'84. It would seem to be a most extraordinary exception if, after the floor of the ocean at great depths had been found to be peopled with life, the fathoms on fathoms of water through which the "sounding-lead" passes to reach those depths are destitute of inhabitants. Although means of definitely knowing the character of the free-swimming life were not at hand, it was certainly conjectured long ago that the water at different depths must have its quota of life. At present, if I have rightly read the accounts which have been published of

* This report is limited to medusæ from north of the Straits of Florida. The Albatross has made a large collection of medusæ in the Gulf of Mexico and Caribbean Sea, which it is proposed to describe in a paper on the Hydrozoa of these localities.

the pelagic life claimed to have been taken at different depths, we are hardly able to definitely state the peculiar characteristics or limits of different bathymetrical zones, as far as those animals which do not live on the bottom are concerned.

There is no other group of marine animals better suited than the medusæ to test the question of whether free-swimming marine animals are represented at great depths by peculiar genera or not, and even before direct observations bearing on this point were made it was pretty generally believed that a knowledge of these animals, if such there be, was destined to throw some light on questions of the bathymetrical distribution of pelagic animals. If the recorded depths from which medusæ are found can be trusted, the results of the voyage of the Challenger, bearing on this point, show that the medusan group has a great bathymetrical distribution. From new facts published in the present paper I am not sure that we can suppose certain of the medusæ recorded by the Challenger from great depths do not also live and flourish at or near the surface. It is not in the province of this paper to examine the methods by which it is known that a genus recorded from, for instance, 1,200 fathoms really came from that depth. I leave this question to the collector; but it may be well to remind the reader that the methods of determining the exact depth at which a free-swimming animal entered the dredge, or in case of a *Rhizophysa*, became entangled on the rope, may or may not be the depth of the sounding. There is a call for greater accuracy in a determination of the exact depth from which a deep-sea medusa is taken, and for an improvement of apparatus used in this kind of collecting. In the case of fixed hydroids, or such medusæ as *Cassiopea* and others, which live upon the bottom, the determination of the depth at which they live is an easy task. With genera as *Atolla*, *Rhizophysa*, and others, this determination is more difficult. The depths at which medusæ are reported in the present paper, and the same is probably true of those recorded by Hæckel, Studer, and others, must therefore be viewed in the light of what has been said above. There is no reason to deny the existence of deep-sea medusæ confined to great depths, and on the other hand nothing to show, without doubt, that the same jelly-fishes, with the exception of those mentioned, are not also found at the surface.*

The importance, from a morphological stand-point, of definitely answering the question whether medusæ are confined to certain depths is

* We can hardly hope, in the imperfection of our knowledge of the limits of the habitat of the so-called deep-sea medusæ, for an answer to the many interesting questions concerning them which are suggested by this condition of life. Of the nine Craspedote medusæ which, according to Hæckel, "have either adapted themselves by special modifications of organization to such a mode of life, or which give evidence by their primitive structure of a remote phylogenetic origin," one genus at least is known to come to the surface. *Atolla*, which is certainly one of the most striking of these genera, was taken in one instance (*A. Bairdii*) from the surface waters of the Gulf Stream.

very great. I can at present imagine no place on the globe where the uniformity of conditions under which medusæ are placed can be the same as at great depths of the ocean. I do not mean necessarily on the floor of the ocean, since that may be raised or depressed, and the varieties of conditions which come from such motions may result, but in the depth of the sea, separated from the surface by a wall of water of great depth, and from the ocean-bed by a similar wall of equal amount. Here, if anywhere, may we look for the continuance of ancestral features unmodified by environment. On this account the determination of the bathymetrical limits of free medusæ no less than that of those animals which inhabit the bottom is a most important thing, and from it should be eliminated all possibility of error. I have been struck, in looking over deep-sea medusæ with the predominance of those which are placed in the Acraspeda as compared with hydroid gonophores. This condition may spring from the fact that the former are larger and more easily seen than the latter, or from a lack of hydroid gonophores at great depths. Several observers have already noticed the predominance of the Plumularidæ and allied Sertularian genera at great depths, while hydroids with free medusiform gonophores, as far as our knowledge now goes, do not form a large share of deep-sea life. The Plumularidæ have no free medusiform gonophores, as far as known.

Of the medusæ placed among the Acraspeda which I have studied the majority are allied to the simpler genera represented by the family of Ephyridæ. These are regarded as closely approaching the ancestral form, Ephyra, from which a great group of medusæ has sprung. If it should be found, on a larger acquaintance with these animals, that they conform to the law which they seem to indicate, we may have new facts of greatest importance in the study of the phylogeny of the medusæ. It is self-evident, I think, that if medusæ are confined to certain depths and cannot penetrate below them in younger or adult stages, a development without a fixed Scyphostoma stage must be the only means of development from the egg in these genera. We may find, as in *Cunina*, commensalism or parasitism, or even a free nurse akin to that of the "mother bud" of *Cunina*, as recorded by Metschnikoff and others; but the possibility of the depth below which the animal cannot sink being the same as the depth of the bottom would be doubtful. What are the possibilities of a medusa separated by a zone of 1,000 fathoms of water, through which it is supposed that it cannot penetrate, being able to make its way to places of that depth at which it lives for its Scyphostoma to become attached? If we say that the eggs may be dropped and sink to the floor of the ocean, no matter how deep, can we still hold to the proposition that the medusa is limited to any depth? *A priori* then, if medusæ are confined to a certain depth, we must suppose that they can have an attached Scyphostoma only when brought, as planulæ or otherwise, into those regions of the ocean whose floor comes within their bathymetrical zones.

We can, therefore, predict that here we may look for medusæ with a direct development, or at all events for those with an unattached young. We know too little of the embryology of different genera of medusæ to get together enough facts to throw much light on this question. It is among those genera with which the deep-sea Acraspeda have their closest likenesses that we find a direct development, but late researches have shown that even some of the highest also skip the *Scyphostoma* stage, and have a development more like that which is called direct. The so-called deep-sea medusæ seem to me to indicate that the mode of development known as direct is the primal condition, and that the growth in which an attached form enters the series is a secondary modification; but they certainly do not prove such to be the case, and I doubt whether we can demonstrate it as far as they are concerned until the bathymetrical limits of their habitat is known.

The material used in the preparation of this paper was sent me by my esteemed friend, Prof. A. E. Verrill. It is a pleasure to acknowledge this indebtedness. I am also indebted to Mr. R. Rathbun for several interesting specimens, also collected by the Albatross. Many of these are from the Caribbean Sea and Gulf of Mexico, and will be mentioned when the collections from these regions are worked over. The present report considers the medusæ of the Gulf Stream region from Florida to the latitude of George's Banks.

ACRASPEDA, Gegenbaur, 1856.

Family PERIPHYLLIDÆ, Hæckel, 1877.

PERIPHYLLA, Steenstrup.

The genus *Periphylla* appears to be common in the waters of the Gulf Stream. It was first found in American waters by Smith and Harger over George's Bank,* and a brief notice of it was published in the *Trans. Conn. Acad.*, 1874.† In 1880 the Blake collected the same genus‡ off Cape Hatteras (*Bull. Mus. Comp. Zool.*, vol. viii, No. 7). In the report on the Acalephs collected by the United States Fish Commission in 1880–'81, *P. hyacinthina*, St., is recorded from the several localities mentioned below:

Station.	Locality.
	Off Martha's Vineyard:
936	S. by E. ½ E. 104½ miles, surface.
952	S. ½ E. 87½ miles, surface.
954	S. ½ E. 91 miles, surface.
995	SSW. ½ W. 104¼ miles, surface.

The genus *Periphylla* is represented in the collection of 1883–'84 by many specimens, which differ so much in outward appearance, in color

*Its most northern observed limit on our east coast.

†The medusa referred to ? *Carybdea periphylla* is the same as *P. hyacinthina*, St.

‡The medusa referred to *Dodecabostrycha dubia*, Brandt, is *P. hyacinthina*, St.

and form, that I have placed them in two species. These may later be generically divided when live specimens are studied.

The two marked differences in these specimens are as follows:

Certain of them have a brown color, with central disk and corona on the exumbral side, very rough, apparently covered with coagulated slime (?), and with the central disk conical and of small altitude. The specimens referred to *P. hyacinthina*, St., have the bell walls more transparent, and the purple color is seen through the bell walls.

These differences might at first be ascribed to the state of preservation of the specimens, but this is improbable since from Station 2036 we have in the same bottle two of the brown and one of the well-known purple *P. hyacinthina*. The brown species is very much smaller than the majority of the examples of *P. hyacinthina*.

PERIPHYLLA HUMILIS, sp. nov.

Specimens examined.

Catalogue numbers.	Stations.	Locality, N. lat.	Locality, W. long.
		° ′ ″	° ′ ″
8089	2030	39 29 45	71 43 00
9185	2036	38 52 40	69 24 40
9365	2038	38 30 30	69 08 25
9315	2039	38 19 26	68 20 20
9320	2044	40 00 30	68 37 20
9280	2050	39 43 50	69 21 20

The bell is low conical, with diameter double its height. The surface of the umbrella brown, rough, opaque. The central disk and corona of uniform color. Diameter of largest specimen, 18^{mm}, when marginal lobes are expanded; diameter of central disk, 2^{mm}. Diameter of the smallest specimen, 8^{mm}.

When seen from above, the exumbrella is found to be divided into two regions, separated from each other by a coronal furrow. The central region, "zona centralis," "discus centralis," occupies the central portion of the umbrella, while the "zona marginalis" bears the four marginal sense-bodies and the twelve marginal tentacles. The discus centralis is of low altitude, conical, sometimes nearly flat, rounded at the apex. In one or two specimens the elevation of the apex is inconspicuous. No apical opening was seen. The margin of the discus centralis is entire, without sulci radiales. In the largest specimen large (abnormal ?) gelatinous white or translucent warts occur on its sides and outer surface.

The zona marginalis in alcoholic specimens is carried at the same angle to the vertical axis as the sides of the conical "discus centralis," forming a continuation of the former, and in one or two specimens it is at right angles to the vertical axis. In most of the specimens the color of this region is like that of the discus centralis, although it has sometimes a blue and light green color.

The zona marginalis is crossed by sixteen incisions, which extend

radially from the vicinity of the coronal furrow to the abaxial points of the marginal lobes. The coronal furrow is generally smooth, sometimes with walls greenish in color, shallow. Immediately around the coronal furrow is a rough undivided zone, inner corona, which forms the axial region of the corona of the umbrella. The sixteen radial, coronal incisions extend from this region along the middle of the marginal lobes to the abaxial points of the same, alternating about the rim of the bell with the tentacles and the marginal sense-bodies.

By the arrangement of these incisions the base of each marginal lappet or lobe is supported by two thickened gelatinous bodies, one side (axial) of which is formed by the abaxial side walls of the coronal ditch, while the other fuses with thickened socles which support the tentacles and marginal sense-bodies. By their approximation near the free (abaxial) end of the lobe they impart to that region a pointed form. A thin membrane skirts the margin of each marginal lobe, assuming the form of a fringe. By the arrangement of the radial furrows, which are found alternating with the tentacles and sense-bodies, it will be seen that the coronal part of the umbrella is made up of sixteen gelatinous blocks, sharply marked off from each other by the radial furrows or depressions, and that these blocks are the thickened basal attachments or supports which bear the tentacles and the marginal sense-bodies. Four of these socles carry sense-bodies; twelve bear the tentacles. There are consequently three tentacles between the members of each pair of sense-bodies. The marginal lappets, when the animal is alive, are probably abaxially placed, acutely pointed, although more or less ragged in alcohol, on account of the rupture and distortion of the marginal membrane.

The tentacles are long, stiffly extended, thick at base, which commonly bears on the external surface a characteristic inflation, not unlike the warts mentioned on the exumbrella, reaching along the outer wall for a few millimeters in length. In some specimens this inflation becomes a globular sac of whitish color; in others it has a chestnut-brown color. The color of the tentacles in two specimens is a bright yellow, while that of the peculiar enlargement or inflation of the wall near the base of attachment is brown in these specimens. The constancy of this enlargement of the base of the tentacle in this species, and its almost uniform absence in the transparent species (*hyacinthina*), has led me to regard it as probably a specific character. It may, however, be of abnormal growth. The specimens are too imperfect for me to observe the character of the sense-bodies, but they probably closely resemble the same in *P. hyacinthina*, St. They are four in number, and prominent, covered above by an extended lappet or hood.

The subumbrella is made up of a central and a peripheral region, of which the former is wholly occupied by the stomach. The sixteen radial grooves or furrows of the exumbral side of the corona are represented on the subumbral side by the same number of radial furrows in the marginal or coronal umbrella region. These furrows are rendered

prominent by the bases of attachment being left in intaglio by the muscular regions which separate them. They follow the same radial course as the exumbral depressions in the marginal lappets above, and seem to indicate the points of fusion of the upper and lower umbral walls. The exumbral furrows mark the lines of attachment of ends of the muscles, which on the subumbral side are connected by a narrow zone formed of sixteen muscular swellings homologous with the coronal muscle of the subumbrella of *Atolla*, where, however, instead of being broken or externally depressed at its attachments, the muscle is continuous, at least in *Verrillii* and *Bairdii*. In *Periphylla* there are sixteen subumbral radial muscles separated by as many radial furrows. A radius, therefore, which passes through a tentacular base or the style of a marginal sense-body bisects one of these muscles, which together form the coronal subumbral zone. On the inner boundary of this zone begins the region of the proboscis or stomach, which occupies the whole central part of the subumbrella. The arrangement of the parts which form the stomach walls could be well studied in two specimens in which the upper surface of the bell was more or less infolded, and the coronal part brought to the level of the apex of the bell, while the stomach walls are stiffly protruded. The stomach or proboscis has the form of a sac which is made up of plates of different sizes united together. From a point cut by the radius passing through the middle member of the three tentacles which alternate with the four sense-bodies, two-thirds the distance between the center and bell margin, a thickened support for the stomach walls is found. This support spreads out into a flat plate, which, becoming broader, unites with a similar support from the next quadrant, and in that way the completed stomach wall is formed. The portion of the stomach wall adjacent to the lips of the mouth has the same color in the alcoholic specimens as the marginal lappets. The lips are destitute of marginal tentacles, although the rows of gastral filaments can be seen on the inner stomach walls, and one or two protrude outside the mouth.

PERIPHYLLA HYACINTHINA, Steenstrup.

Specimens examined.

Catalogue number.	Stations.	Locality.		Depth.
				Fathoms.
9724	936	Off Martha's Vineyard, S. by E. ½ E. 104½ miles.		705
9725	936			
9726	936			
9723	995	SSW. ½ W. 104½ miles		358
		N. lat.	W. long.	
9312	2037	38° 53′ 00″	69° 23′ 30″	1,731
9283	2043	39 49 00	68 28 30	1,467
9318	2044	40 00 30	68 37 20	1,067
9720	2044	40 00 30	68 37 20	1,067
9311	2045	40 04 20	68 43 50	373
9297	2047	40 02 30	68 49 40	389
9295	2051	39 41 00	69 20 20	1,106
9184	2075	41 40 30	65 35 00	855
8743	2110	35 12 10	74 57 15	Surface.

Sub-family COLLASPIDÆ, Hæckel, 1879.

ATOLLA, Hæckel, 1879.

(Plates I–V.)

The genus Atolla, one of the most extraordinary forms of deep-sea medusæ, is represented in the collections made by the Albatross by several specimens. It will probably be found when live specimens are studied that we have in the Gulf Stream more than two species, which are possibly represented in this collection. The differences which the several specimens exhibit are very great, but due to the state of preservation rather than to structural modifications. At present they are all placed in two species, to which I have given the names *Bairdii* and *Verrillii.*

The only known examples of this genus which have been described are five specimens collected by H. M. S. Challenger* and placed in the species *Wyvillii* by the founder of the genus.

Hæckel unites *Atolla* with a like genus, *Collaspis*, in a sub-family, the Collaspidæ,† of which these two genera, each with a single species, are the sole members.

The most important difference between these two genera lies in the structural feature, observed by Hæckel, that in *Collaspis* the genitalia are regularly distributed at equal distances from each other on a ring situated between the peripheral border of the line of junction of the proboscis and the inner edge of an inner coronal muscle (*mus. cor. i.*), while in *Atolla* these sexual bodies are arranged in four pairs, the intervals between the pairs being greater than that between the two glands which compose a single pair. In several of the specimens which are found in the collection before me and included in the genus *Atolla*, the whole lower floor of the subumbrella was so ruptured in capture that it is impossible for me to investigate the character of the genitalia and their location in reference to each other. In still others, characters of both genera appear on the same specimen, so that, from what I have seen of the alcoholic representatives and the tendency to distortion which they exhibit, I find great difficulty in separating the two genera. The resemblances between the organs which were present and the same in other specimens, where the ovaries have the arrangement characteristic of *Atolla*, have led me to refer all my specimens to this genus.

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* Report on the Scientific Results of the Voyage of H. M. S. Challenger. Zoology. Vol IV. No. II. Report on the Deep-sea Medusæ dredged by H. M. S. Challenger, by Prof. Ernst Hæckel, M. D., Ph. D.

† *Op. cit.*, p. iii. By an unfortunate typographical error in his diagnosis of the Collaspidæ, Hæckel excludes in this place the genus *Atolla* by assigning to the sub-family "16 to 18 sense-clubs" or marginal sense-bodies. *Atolla* has from (19 *teste* Hæckel) 22–28 sense-clubs as far as yet observed. The reading of the diagnosis in his System der Medusen is 16–32, which was probably intended to be repeated in this instance. In Plate 29 (*op. cit.*), Figs. 1, 2, 3, where the marginal lappets ought to be shown, they are omitted. In Fig. 4 they are represented.

The most marked character which strikes the attention in looking at the disk of *Atolla* from the aboral or exumbral side is a ring-shaped furrow or ditch (*fos. cor.*), situated at about two-thirds the distance from the center of the disk to its periphery. This ditch will be called, in our subsequent descriptions, the coronal ditch or furrow (*fos. cor.*); the central part of the disk, the discus centralis, or central disk (*dis. cent.*), and the peripheral portion the corona. The separation of the corona from the central disk by the coronal furrow has suggested the generic name, *Atolla*.

A second marked feature, which a superficial study of the exumbral side of the umbrella partially shows, is a strong peripheral muscular band (*mus. cor. c.*) which, although belonging to the subumbral side of the disk, is, in most of the specimens, by its contractions, brought into view on the exumbral side, so that it appears as a light brown ring on the margin of the subumbrella, showing through between the intervals of the gelatinous blocks which carry the marginal lappets. This muscle (*mus. cor. c.*) reaches, in *Atolla* and *Collaspis*, a most extraordinary development. The umbrella of *Atolla* in alcohol is translucent and has a bluish color, while the muscle, as may be said also in relation to other muscles in the same medusa, has an opaque, light chestnut-brown color. Between the coronal ditch and the peripheral muscle thus abnormally brought to view on the exumbral side of the disk lie two rows of gelatinous blocks, confluent below the surface, yet superficially marked off, alternating with each other, which form the corona and bear either a single tentacle or a small marginal sense-body with marginal lappets. The short, solid (?) muscular tentacles (*ta*), in many alcoholic specimens rise almost perpendicularly from the exumbral surface of the corona, while the sense-bodies are borne on quadrangular or polygonal gelatinous blocks (*soc. s. b.*), the bases of which are dovetailed into the interstices on the peripheral side of those gelationus blocks (*soc. ta*), which bear the tentacles.

Seen from the subumbral side, the large peripheral coronal muscle (*mus. cor. c.*) is found to have a greater width than when seen from the exumbral. The most characteristic feature, however, of this region is the stomach hanging from the subumbral walls of the middle of the lower umbrella. This organ is a bag-shaped structure fastened on a cross-shaped double line, with a simple mouth (*or*) opening at the free end. The stomach opens by four orifices at the angles of the cross-shaped body into an annular sinus included in the walls of the corona. In the walls of the stomach are four broad, pouch-like plates (*lb. per.*) alternating with as many narrow lobes (*lb. int.*), which are triangular-shaped. The latter fuse with the lower walls of the umbrella and form the re-entering angles of the cross-shaped attachments. On the inner surface the "phacellen" are arranged in lines and are thickly matted together in the stomach cavity, imparting a purple color to the inner walls.

Of the two new species here described, *A. Bairdii* more closely resembles *A. Wyvillii* than does *A. Verrillii.* They are easily distinguished by the narrow and long socles of the sense-bodies in the latter, and the greater prominence of the external coronal muscle as seen from the exumbral side. It must be confessed that all these features may be the result of alcoholic contraction, and it will be no surprise to me if live specimens shall show that we have here only a single species.

ATOLLA BAIRDII, sp. nov.

Specimens examined.

Catalogue numbers.	Stations.	Locality— N. lat.	Locality— W. long.	Depth.
		° ′ ″	° ′ ″	*Fathoms.*
6723	2104	38 48 00	72 40 30	991
8743	2110	35 12 10	74 57 15	Surface.

Exumbrella.—The central disk, discus centralis (*dis. cent.*), is disk-like, with the upper surface slightly rounded. The walls are translucent, so that the appendages to the lower floor can be indistinctly seen through them. Color, slightly blue, with iron-red rust-colored patches, especially on the border of the coronal furrow. Twenty-two slight notches on the periphery of the central disk, each notch corresponding with the tentacular socle. Diameter of central disk, 53^{mm}; altitude, about 10^{mm}.

The coronal furrow (*fos. cor.*), which separates the central disk from the corona, has a reddish color in certain portions. Furrow deep, broad at bottom, slightly overarched by the wall of the central disk.

The corona or peripheral region of the exumbrella is bounded axially by the coronal furrow, and includes all that part of the umbrella on the abaxial side of the coronal furrow. It is composed of four regions, which are as follows, beginning with the most axially placed: 1. Undivided zone, whose inner walls are the abaxial walls of the coronal furrow, and whose outer bounding line is indicated superficially by a slight groove of reddish color (*m. cor.*). This zone may be called the inner corona (*i. cor.*). 2. A zone formed of twenty-two gelatinous blocks, placed side by side, bearing the tentacles, and separated from each other by shallow grooves also of reddish color. This is the zone of the tentacular socles (*soc. ta.*). 3. A zone of twenty-two gelatinous blocks, non-continuous, separated from each other by the tentacles. These blocks bear the marginal sense-bodies (*mg. sb.*), and are the socles of the rhopalia or sense-bodies (*soc. sb.*). 4. A peripheral region of the corona made up of forty-four marginal lappets, or patagia (*mg. lp.*).

1. The internal corona (*i. cor.*) is a narrow ring-shaped zone, undivided, its inner wall forming the peripheral wall of the coronal furrow. Its outer border is marked by the slight furrow (*m. cor.*) which separates it on the peripheral region from the second zone, that of the tentacular

socles (*soc. sb.*). Its division from the latter is only superficial, for interiorly its gelatinous substance is confluent with the zone of tentacular socles. In the type specimen there is considerable width to this zone. In live specimens it is probably not as broad, although the zone of tentacular socles probably does not adjoin the coronal furrow, as Hæckel describes and figures them in *A. Wyvillii.*

2. The zone of tentacular socles (*soc. ta.*) is composed of twenty-two gelatinous blocks, placed side by side, separated from each other laterally and superficially by small, shallow, radial grooves, and marked off from the inner corona (*i. cor.*) by a ring-shaped groove (*m. cor.*). The radial markings which separate the different components of the zone are superficial, and the members internally form together a solid gelatinous zone. Each gelatinous block or socle bears a tentacle. The socle (*soc. ta.*) is convex above, rounded abaxially, slightly cuneiform. Abaxially the periphery is slightly angular, with two lateral faces, and an abaxial face from which hangs the tentacle (*ta.*). The polyhedral shape of these bodies, described by Hæckel in *A. Wyvillii*, does not exist in this species, and may in his species be in part a result of contraction. The tentacles (*ta.*) vary in length, the longest projecting outside the abaxial margin of the patagia. They are stout at the base and taper uniformly to the distal extremity; tentacles flexible. On the lower subumbral side (Pl. II) they are fastened by two muscles with insertions under the coronal muscle. Width of tentacular socle, 10^{mm}; length, 5^{mm}. Tentacles, 15–20^{mm} long; 4^{mm} diameter at base.

3. The socles of the sense-bodies (*soc. sb.*) are twenty-two in number; they lie between the tentacular socles in the intervals on the peripheral margin and alternate with the tentacles. The members of this zone do not join each other. On their subumbral side lies the external coronal muscle (*mus. cor. e.*). The plane of their upper or exumbral surface is lower than that of the tentacular socles. Width, 10^{mm}; length, 10^{mm}. On the medial (abaxial) part of the exumbral surface there is a brown, crescentic-shaped body, with concavity looking outward, in which lies a marginal sense-body (Pl. III, Fig. 2). In this specimen these bodies are poorly preserved. There is nothing, however, to indicate that they are poorly developed, although such may be the case, as Hæckel has found in his species. When the medusa is seen from the exumbral side (Pl. I) only a small part of the external coronal muscle (*mus. cor. e.*) can be seen in the intervals between adjacent socles of the sense-bodies in the typical specimen.

4. The most peripheral zone of the corona is made up of forty-four thin flaps, marginal lappets, or patagia (*mg. lp.*), which as a general thing are poorly preserved. Two of these arise from each socle of the sense-body (*soc. sb.*) on the peripheral edge, and between them lies the sense-body (*mg. sb.*). Each patagium is leaf-like, with rounded rim. Length, 10^{mm}; width, 5^{mm}.

Subumbrella.—We recognize in the subumbrella (Pl. II) a large cen-

tral proboscis, around which is a zone in which are placed the sexual bodies (*oa.*). Outside of this zone is a third zone, the inner coronal muscle (*mus. cor. i.*), on the periphery of which is the external coronal muscle (*mus. cor. e.*). The very periphery is made up of the under surfaces of the socles of the sense-bodies and marginal lappets (*mg. lp.*).

Outside (abaxially) of the musculus coronalis externus (*mus. cor. e.*) the lower surface of the twenty-two socles of the sense-bodies (*soc. sb.*) and the subumbral surface of the marginal lappets show nothing peculiar. The socles of the sense-bodies (*soc. sb.*) have, however, a small, medial, radial groove, more or less reddish in color, which extends from the sense-body to the edge of the coronal muscle radially along its medial line.

The musculus coronalis externus (*mus. cor. e.*) is a very powerful ring-shaped muscle of light-brown color, not visibly marked into regions, and opaque. Width, 5^{mm}.

Axially to the external coronal muscle there is a musculus coronalis internus (*mus. cor. i.*), a thin, transparent muscle, through which can be seen twenty-two pairs of radial clasps (*cl.*), which bind it to the lower surface of the umbrella, separating chymiferous pouches, which extend radially from a coronal "intestine" yet to be described. Each pair of clasps correspond with a radius which passes through a sense-body.

Between the inner edge of the internal coronal muscle and the line of attachment of the proboscis is a zone 10^{mm} wide, in which lies the kidney-shaped sexual organs (*oa.*). The lower wall of this region is muscular and membranous, formed of longitudinal and radial fibers, which in eight radii become radially concentrated and form the deltoid muscles (*mus. delt.*), which separate the sexual glands from each other. The width of these muscles varies, but I do not find the regularity of this variation as marked in our species of *Atolla*, as Hæckel describes it to be in *A. Wyvillii*. In the two sexual bodies which I have figured (*oa.*), the deltoid muscle which separates them is narrower than that (*mus. delt.*) which separates the pair from an adjacent pair. The lower wall of the zone in which the genitalia lie covers the sexual glands (*oa.*), so that these bodies lie in a circular sinus, which is shown in one of the intervals which has been cut into between two glands. (See interval between upper ovary (*oa.*, Pl. II) and that at left.) Each sexual body is bean-shaped, inflated with ova, with hilum axially placed. Diameters, 12^{mm} and 10^{mm}. Color, chestnut brown. The internal zone of the subumbrella is occupied by a bag-shaped structure with dark blue or purple walls, which form the stomach or proboscis. The walls of this structure are formed of eight sections of two sizes. The four perradial sections (*lb. per.*) are broad and bag-shaped (25^{mm} in breadth), tapering from insertion to the edge of the open mouth (*or.*). The interradial (*lb. int.*) sections, which alternate with these, are narrower (5^{mm} wide), likewise tapering, and fused with the walls of the subumbrella. The bag-shaped structure or proboscis formed by the combination of these sections is

30–50^{mm} long, and is united to the walls of the subumbrella on a double line, forming a figure shaped somewhat like a Greek cross, the re-entering angles corresponding to the smaller or interradial sections (*lb. int.*), which are fused with the walls of the lower floor of the disk, forming the "cathammal plates." As nearly as could be observed, the free lips of the proboscis are smooth. The "phacellen" are in poor condition. Flakes of purple or brown color in the interior of the stomach walls are the only remains of them which are visible.

The stomach cavity opens by four orifices into a circular sinus, which lies in the corona. These openings are situated at the extremities of the cross-shaped union of stomach walls and subumbrella. The coronal sinus, sometimes called the intestine, lies between the musculus coronalis internus and the upper walls of the corona, and sends out radially twenty-two pouches of the peripheral organs. When a portion of the musculus coronalis internus is cut through, as at one of the deltoid muscles, the scalpel penetrates the coronal sinus. It is a ring-shaped recess, upon the upper wall of which—the lower floor of the disk—a ring-shaped groove, corresponding on the under surface of the corona to the coronal furrow on the upper, is seen. The coronal sinus is marked out on the upper wall in such a manner that the axial portion is inclosed above by a portion of the lower surface of the discus centralis, and the abaxial by the lower wall of the internal corona.

The twenty-two pouches which extend radially from the coronal sinus to peripheral organs pass below, or in a natural position of the medusa, above the musculus coronalis internus and the musculus coronalis externus, and are separated laterally by a pair of clasps (*cl.*), which serve to bind these structures to the lower side of the disk. The clasps lie in the radii of the sense-bodies of the umbrella margin, while between the members of a pair there is a narrow tube which extends from the coronal sinus to the vicinity of the sense body. The ultimate termini of this and the other pouches were not traced. Our specimen was not well enough preserved to follow out with satisfaction the minute structure and course of these organs in the elaborate way that Hæckel was able to do in *A. Wyvillii.*

ATOLLA VERRILLII, sp. nov.

(Plates IV and V.)

Eight specimens of an *Atolla*, which differs from the preceding as well as from any known species, were examined. They have long and narrow sense-socles, which are more or less quadrangular, almost cartilaginous in texture. The marking, on the exumbral side of the umbrella, which separate the socles of the sense-bodies from those of the tentacles and the inner corona, as already described, are not seen in any of the specimens of *A. Verrillii.*

Of the eight specimens some are mutilated, perhaps distorted or badly

preserved. The following description was made from all the specimens. No. 2 of the tables is figured in Pl. IV, and No. 4 in Pl. V.

Specimens examined.

No.	Catalogue numbers.	Stations.	Locality— N. lat.	Locality— W. long.	Depth.
			° ′ ″	° ′ ″	*Fathoms.*
1	9182	2034	39 27 10	69 56 20	1,346
2	9181	2037	38 53 00	69 23 30	1,731
3	9314	2039	38 19 26	68 20 20	2,369
4	9183	2040	38 35 13	68 16 00	2,226
5	9301	2042	39 33 00	68 26 45	1,555
6	9317	2044	40 00 50	68 37 20	1,067
7	9309	2045	40 04 20	68 43 50	373
8	6250	2094	39 44 30	71 04 00	1,022

These specimens will be known throughout my descriptions by the Arabic numbers (1-8) prefixed to the catalogue number.

The following table represents in tabular form the number of tentacles, sense-bodies, marginal lappets, diameter of the central disk, and width of the corona in each specimen. The diameter of the central disk, measured from the inner walls of the coronal ditch on each side, seems to vary less from the action of the alcohol than the true diameter from margin to margin. In smaller specimens it is extremely difficult to tell from the abnormal position of the subumbral muscle the external limit of the corona. The measurements, therefore, of the latter part (corona) are not relatively so accurate as those of the central disk. From the nature of the case, all measurements are probably too small for living representatives.

No.	Tentacles.	Sense-bodies.	Marginal lappets.	Diameter of central disk.	Breadth of corona.
				mm.	*mm.*
1	22	22	44	45	14
2	28	28	56	45	10
3	22	22	44	18	5
4	22	22	44	40	10
5	24	24	48	14	5
6	23	23	46	21	5
7	22	22	44	21	5
8	24	24	48	25	5

Umbrella flat, discoid, with a diameter six to eight times the vertical thickness at the center. Umbrella is divided into two regions, a central disk (*dis. cent.*) and a peripheral corona. The breadth of the corona is about one-quarter the diameter of the central disk. The diameter of the central disk varies in different specimens from 14 to 45^{mm}; breadth of the corona from 5 to 14^{mm}. Between the central disk and the corona is a coronal furrow (*fos. cor.*). The inner border of the corona, which forms the outer wall of the coronal ditch (furrow), is formed by a thin yet strong muscle. There are from 22 to 28 tentacles, the same number of sense-bodies and twice as many marginal lappets.

Habitat.—This species has been collected, as shown in the above table, between latitudes 38° 19′ 26″ north and 40° 4′ 20″ north; longitudes 68° 16′ 00″ west and 71° 4′ 00″ west. It was taken from 373 to 2,369 fathoms.

Umbrella.—Two different regions of the umbrella, called the aboral or exumbral and the oral or subumbral side, can be distinguished in these specimens of *Atolla.* If the medusa is free-swimming, the former is probably uppermost as it moves in the water, but the stiff, gelatinous, almost cartilaginous character of the disk suggests that it has little power of motion in the central disk.* The umbrella is flat, discoidal, of a slight blueish tinge. The consistency of the bell is at times cartilaginous. The wall of the exumbrella is divided by a circular furrow (*fos. cor.*), which is almost as deep as the thickness of the umbrella. In two specimens well-marked radial lines or slight depressions, sulci radiales (*s. r.*), are found on the peripheral region of the central disk; in the other specimens these markings are not as plainly seen. When present the number of radial markings (*s. r.*) on the exumbral surface of the central disk correspond with the number of tentacles or marginal sense-clubs. These bodies correspond with what Hæckel has described in *Wyvillii* as the "sulci radiales." In *A. Wyvillii*, however, they are broader as compared with their length than in this species. The corona of the umbrella is seen on the exumbral side to be marked off into two zones of gelatinous blocks, the innermost zone (*soc. ta.*) bearing the tentacles; the outermost, the sense-bodies. In some of the specimens the exumbral surface of the corona appears almost smooth, in others the outer surfaces of the gelatinous blocks are rough or channeled. The external faces of the tentacular ring of blocks are more prominent than those of the sense-organs, and are well marked on larger specimens. There are as many of the tentacular blocks as of tentacles. The inner faces of the tentacular blocks are fastened to a flat circular muscle, which forms the outer wall of the coronal ditch. On each side the tentacular block fits closely upon its neighbor and fuses with it, forming a continuous ring. On the exumbral side the block is slightly convex, and on either side, extending from the upper surface to the sides which adjoin, is a small polygonal facet. The division of the tentacular blocks is superficial. The base of the tentacle occupies an abaxial facet, while the two lateral faces leave an interval into which fit the alternating gelatinous bodies of the sense-blocks. The tentacles are in most of the specimens short, stiff, and very cartilaginous. Although Hæckel describes their base as penetrated by a tube in his species, in *Verrillii* I was unable to discover any cavity or cœcal ending of a tube. On the side turned to the central disk there is a strong muscle, which arises from

* The great development of the subumbral coronal muscle indicates that *Atolla* does not resemble *Cassiopea* in living upon the bottom. It is probably a free-swimming medusa. A proboscis, like that of *Atolla*, implies food of large size, and not the small animals upon which *Cassiopea* feeds.

the face of the gelatinous blocks already mentioned, while on the peripheral side are two strong muscles, which coalesce in the smaller part of the tentacle, forming a large part of its wall, but which divide into two muscles on the base of the tentacular socle. Passing around the margin of the corona of the disk, these two muscles are inserted under the high coronal muscle (*mus. cor. e.*), which forms the marginal boundary of the exumbral side of the disk. Both of these muscles, as well as the smaller muscle on the side of the tentacle turned towards the center of the umbrella, have a brown color in the conservative fluid (alcohol), in which the medusæ are preserved.

Perhaps the most characteristic organs of the corona are the sense-clubs and the gelatinous elevations upon which they are carried. Strangely enough, of the five specimens observed by Hæckel, and of the examples which I have studied, only two have a multiple of the number four in the number of these organs. When we reflect how few known instances among medusæ there are which do not have this numerical resemblance and relationship, the exceptions become even more prominent. I believe, however, that this departure from the normal number is without morphological significance. The sense-bodies are long, narrow, borne upon the members of the external zone of gelatinous blocks (*soc. sb.*), and are of the same number as the tentacles. The bases of these organs are cubical or quadrangular pieces of translucent gelatinous character, with flat lateral faces and slightly curved upper face. In alcohol the distal ends are bow-shaped, curved downward. On each side at the free extremity there is a flat leaf-like appendage or patagium (*mg. lp.*), in the angle between which lies the sense-bulb. In most of the specimens the sense-bulb, although poorly preserved, is well developed and prominent, while the hood is inconspicuous or wholly absent. The patagia were neither as broad nor as long as in the closely allied *Wyvillii*, where, according to Hæckel, they are in the specimens which he studied "invariably torn and badly preserved." I was unable to trace the tubes from the chymiferous system of vessels into the sense-bodies, although they probably have the same course and general character as in the species *Wyvillii*.

Subumbrella.—The subumbrella is more complicated in its structure than the exumbrella, and from it hang several important structures. The tentacles, which, in a majority of Acraspedote medusæ, belong to the appendages of the subumbrella and their homologues, the sense-clubs, have been pushed around the margin of the corona to the exumbral side by the great development of a circular muscle (*mus. cor. e.*) already mentioned, as seen in part on the exumbral side, and which forms a large portion of the margin of the subumbrella. Within this large peripheral muscle, which is composed of a number of parallel layers, is a second smaller and concentric thin circular muscle (*mus. cor. i*), the inner edge of which forms the inner rim of the corona. In the species *Wyvillii*, according to Hæckel, "the subumbrella is divided in the

same way as the exumbrella, by a deeply incised coronal furrow, into two separate principal areæ, which are connected only by the thin gelatinous ring at the bottom of the coronal furrow." In most of my specimens of *Verrillii* I was able to discover this furrow on the subumbrella, but in none was it so deeply incised as in *Wyvillii*. The coronal ditch can be seen on the oval side of the umbrella, and can be used as a line of division between a central subumbral disk and a subumbral corona. The latter region is formed by two zones, an external peripheral opaque muscle (*mus. cor. c*), and an inner, thin, translucent, (*mus. cor. i*). In most of its specimens there are no deep radial furrows on the subumbral surface of the corona, and the lower surface of the corona is smooth. Through the translucent inner muscle of the corona on the subumbral side can be seen the triangular bases of attachment of the two muscles to each tentacle already described, alternating with radial gelatinous clasps (*cl.*), by which the circular muscular system or the lower floor of the subumbrella is bound to the lower surface of the umbrella. These pairs of clasps (*cl.*) lie in the same radii as the sense-bodies, and equal them in number in different specimens.

From the subumbral wall of the central disk hang some of the most important organs of the digestive and generative system. The wall itself is fastened to the lower surface of the umbrella by four gelatinous pillars, which are so broad that small orifices only remain between them. The space left between the subumbral wall and the lower surface of the umbrella is the stomach, opening by these four orifices into a coronal sinus. The walls of the subumbrella, or lower floor of the disk, are muscular, in which is a layer of circular fibres, and on the lower surface eight well-developed deltoid muscles passing over or bridging the space between the central disk and corona, thus helping to form the membrane-like body at the fundus of the coronal ditch. These deltoid muscles are 45° apart, separating the outer appendages of the central disk in the following manner:

The most peripheral set of appendages to the wall of the subumbrella is a ring of oblong, bean-shaped bodies (*oa.*), eight in number. These bodies are the ovaries, and they are found on the outer rim of the subumbral portion of the central disk. The four alternate radial deltoid muscles just mentioned separate these eight glands into four pairs, of which, consequently, there is a single pair in each quadrant. An inequality in the distances between adjacent sexual glands is one of the prime differences between the two genera *Atolla* and *Collaspis*.

The whole of the middle region of the subumbral surface of the central disk is occupied by the walls of the proboscis. In the largest specimens this portion is wholly destroyed, and only one or two of the sexual glands remained, while in the smaller I was able to investigate the main peculiarities of this structuie.

The general shape of the proboscis of *Atolla* recalls that of the genus *Linerges*, and has more likenesses to that of the Ephyridæ than the cur-

tain-like folds or solid consolidated mouth-parts of a majority of the Acraspeda. The proboscis is a bag-shaped structure confluent with the walls of the subumbrella. It is free at one end and open at the opposite. This structure is fastened to the umbrella walls on a line which forms a cross shaped figure, by which four lateral extensions and four re-entering angles are formed in its external walls. The terminal opening or mouth is smooth and destitute of appendages. The external surface of the walls is quite smooth.

The walls of the proboscis are formed of eight parts, four broad alternating with four narrow. The broad lobes (*lb. per.*) are bag-shaped; the narrow lobes (*lb. int.*) flat, muscular, narrow. The former are perradial; the latter interradial. At their union a stiff structure is formed which serves as a means of common union and of firm attachment to the lower walls of the umbrella.

On three of the specimens observations were made in relation to the cavity of the disk. The mouth opens directly into the proboscis cavity, or stomach, where we find four double lines of gastral filaments. At its base the stomach cavity is slightly constricted, and from the circular recess, thus partially separated from the stomach, four openings radiate. The roof of the circular recess is formed by the under side of the umbrella, and its floor is made up in part by the subumbrella wall. Its diameter is about that of the diameter of the central disk (*dis. cent.*). The four radial openings communicate with a ring-shaped sinus, "intestine," surrounding the central cavity placed in the corona. I was unable to trace the course of certain radial pouches which were observed to arise from the periphery of the coronal sinus.

Subfamily, NAUSITHOIDÆ, Hæckel, 1879.

NAUPHANTOPSIS, gen. nov.

(Plate VI.)

Nauphanta-like medusa, with thirty-two marginal lobes, twenty-four tentacles, and probably eight marginal sense-bodies. With shallow coronal furrow, and sculpturing on the exumbral side of the corona as in *Nauphanta*. Thirty-two radial exumbral coronal furrows and the same number of rounded elevations, instead of sixteen, as in *Nauphanta*.

The genus *Nauphantopsis*, although closely allied to *Nauphanta*, differs from it so much in the arrangement of the tentacles upon the disk margin and the number of marginal lappets, that I do not hesitate to place it in a new genus. Both genera undoubtedly belong to the same family and are morphologically among the most interesting of all so-called deep-sea medusæ. The single specimen of *Nauphantopsis*, collected by the Albatross, has the central disk, discus centralis (*dis. cent.*), torn away, and with it have disappeared also the stomach and ovaries.

Still the walls of the corona are intact and the marginal lobes, with a few tentacles, are in a good condition for study.

The systematic position of this genus is in the family of Nausithoidæ, and it lies between *Nauphanta*, and *Collaspis* of the Collaspidæ. *Nauphantopsis*, more closely even than *Nauphanta*, is related to the well-known genus *Periphylla* in possessing three tentacles between two marginal sense-bodies. It probably (?) has, however, eight sense-bodies on the disk margin instead of four, as in the last mentioned genus. The sculpturing on the corona of the umbrella also resembles that of *Periphylla* in a distant manner. *Nauphantopsis* is allied to the Periphyllidæ on the one side and to the Collaspidæ on the other.

A single specimen of *Nauphantopsis* was taken by the Albatross at the following station:

Catalogue number.	Station.	Locality— N. lat.	Locality— W. long.	Depth.
		° ′ ″	° ′ ″	*Fathoms.*
9279	2038	38 30 30	69 08 25	2,033

In my description of the species I have availed myself of what is known of the allied genus, *Nauphanta*, to which it has many resemblances in a discussion of doubtful points of structure.

Measurements.

Diameter of the umbrella.	Width of corona.	Length of marginal lappet.	Breadth of lappet.	Length of tentacle.
mm.	*mm.*	*mm.*	*mm.*	*mm.*
70	10	10	8	80

In the type specimen of *Nauphantopsis* I was unable to discover with certainty the character or number of the marginal sense-bodies. If these bodies are present they are probably very obscure and simple, as might be expected from the anatomy of those of closely related genera. As in the genus *Nauphanta*, the depth at which these medusæ occur has probably led to a reduction in the complication and size of these bodies. Three tentacles in adjacent marginal indentations were observed, arising in a position similar to that of the tentacle in *Nauphanta*. Considering the number of marginal sense-bodies as eight, as in *Nauphanta*, we find there are eight intervals or octants, each with three tentacles, or twenty-four tentacles in all.

We can hardly suppose that there are only four sense-bodies, since from their probable arrangement on the bell margin we would have twenty-eight intervals (indentations between marginal lappets) to be occupied by twenty-four tentacles, or six in each quadrant and two remaining, nor sixteen sense-bodies, since I have observed in one segment three tentacles side by side. Sixteen sense-bodies would imply only

sixteen tentacles, considering the number of marginal lappets as thirty-two. The indications, therefore, are that there are either eight sense-bodies and twenty-four tentacles, or thirty-two tentacles and no sense-bodies. I do not entertain a belief in the latter condition, but from my observation of three tentacles, following each other, consider the former as a correct interpretation. To that conclusion also the various affinities of medusa with *Nauphanta* also point. If sense-bodies are so difficult to find in a specimen the margin of which is so well preserved, we may well conclude that they are rudimentary or possibly functionless.

The genus *Nauphanta*, to which *Nauphantopsis* is most closely allied, differs primarily from it in the arrangement of the tentacles on the bell margin. Whatever the number of tentacles may be found to be by later research, the following fact is the result of direct observation: Three tentacles are found in three consecutive indentations between the marginal lappets in *Nauphantopsis*, while in *Nauphanta* a tentacle alternates with the marginal sense-body. *Nauphanta* has sixteen longitudinal furrows extending across the corona, while *Nauphantopsis* has thirty-two. There are thirty-two marginal lappets in *Nauphantopsis;* sixteen in *Nauphanta*. Hæckel describes, in addition to the sixteen deep furrows, which traverse the whole corona of *Nauphanta*, sixteen others, shallow, found intermediate between the deeper in the peripheral part of the corona and on the central disk. These smaller furrows, thirty-two in number, likewise exist in *Nauphantopsis*, but appear to be less conspicuous than in *Nauphanta*. The shape, size, and border of the marginal lappets in *Nauphanta* and *Nauphantopsis* are very different. The horizontal diameter of *Nauphantopsis* is five times that of *Nauphanta;* its height certainly from three to four times as great.

On the exumbrella the gelatinous blocks are convex, and at the peripheral part are very prominent, projecting in a considerable elevation of knot-like shape, slightly incised midway in their breadth, although the incisions are very shallow as compared with similar "shallow furrows" in *Nauphanta*. On the subumbral side of the umbrella two rounded continuations of the gelatinous blocks were noticed as forming the base or basal supports of the marginal lappets. No great variations in size of the gelatinous blocks were noticed. No regular variation by which the blocks which lie in the same radii as the tentacles are larger than those which lie in the radii in which sense-organs lie was observed in the single specimen of *Nauphantopsis* which was studied. It is certainly not as prominent, if it does exist, as in Hæckel's figures of *Nauphanta Challengeri*, Hæck.

NAUPHANTOPSIS DIOMEDEÆ, sp. nov.

(Plate VI.)

Bell cap-shaped or high disk-shaped, with walls probably somewhat vertical, as in *Linerges*. The exumbrella is divided into a central disk

(*dis. cent.*) and a peripheral corona, by a shallow coronal furrow (*fos. cor.*). The exumbral wall of the former (*dis. cent.*) is horizontal, that of the latter somewhat inclined to a perpendicular. Corona crossed by thirty-two deep radial furrows alternating with the same number of radial rounded elevations (*soc. sb.*, *soc. ta.*). The radial depressions alternate with the marginal lappets; the incisions on the bell margin between the marginal lappets correspond to the radial elevations.

The coronal region of the umbrella, which is the only portion of the disk of this medusa which remains, indicates that this portion is ruptured easily from the central disk along the line of the coronal furrow. The coronal furrow, however, has a shallow depth. From the resemblance of *Nauphantopsis* to *Nauphanta* the diameter of the discus centralis is supposed to be about the width of the corona. The corona when seen from the exumbral side (Fig. 2) is found to be composed of two zones, an inner of gelatinous elevations alternating with radial furrows, and an outer of leaf-like flappers or marginal lappets (Fig. 1, *mg. lp*).

In the inner region (axial) the radial furrows extend wholly across the exumbral surface of the corona alternating with the marginal lappets, a furrow ending at the axial end of the medial line of each lappet. The rounded radial elevations (*soc. sb.*, *soc. ta.*), which lie between the radial furrows, are sausage-like structures in half relief on the exumbral surface of the corona. If the division of these elevations into socles of the tentacles and those of the marginal sense-bodies be made, it will be found that there are three contiguous tentacular socles (*soc. ta.*) which alternate with a single socle of the marginal sense-body.

The marginal lappets (*mg. lp.*) are thirty-two in number and are rectangular with rounded free angles. Their walls are very thin except at the base, where they join the zone of the axial region of the corona, after which they increase in thickness. The axial region of the corona is formed of a confluence of the zones of the tentacles and that of the sense-bodies, which are, as we have seen in *Atolla*, sometimes more distinct or differentiated from each other.

The tentacles which remain are long and flexible, arising from the incision between the marginal lappets. In one instance three adjacent tentacles were found, from which fact I was led to conclude that there are twenty-four tentacles in all since there are thirty-two marginal lappets, and I suppose there are eight mariginal sense-bodies. This reasoning is, however, based on the supposition, which accords with the facts in other genera as far as known, that the different sectors of the disk of *Nauphantopsis* resemble each other. A live specimen may show it to be false. When the corona is seen from the subumbral side we see still additional evidences that the walls of the corona are at least as perpendicular as in *Periphylla*. Through the walls of the corona, looked at from the subumbral side, the longitudinal radial depressions, which are so pronounced on the walls of the exumbrella, are easily seen. The surface of the walls of the subumbrella is, however, without protuber-

ances corresponding to the sausage-like bodies of the exumbrella. From the base of attachment of each tentacle to the abaxial end of the radial prominences there extends a short conical spur or rib which recalls similar structures in certain Narcomedusæ.

The lower floor of the umbrella (subumbrella) is made up of a powerful zone, formed by a sheet of muscular fibers scantily developed near the abaxial periphery, but larger and more pronounced near the axial border. The ovaries, stomach, and all those organs which occupy the central portion of the subumbrella are wanting in the specimen before me. They probably closely resemble the same structures in the genus *Nauphanta*.

Family EPHYRIDÆ, Hæckel, 1877.

EPHYROIDES, gen. nov.

(Plate VII.)

There are several small medusæ, members of the family of Ephyridæ, which cannot be identified as belonging to any described genus. In these medusæ it was very difficult to investigate the structure of the subumbrella, although in two specimens at least the umbrella on the exumbral side could be easily studied. One specimen in particular (Station 2042) shows such a characteristic exumbral surface of the disk that there was no hesitation in referring it to an unknown and undescribed genus. The distinguishing character of *Ephyroides* is the presence of from sixteen to thirty-two, or more, rounded, radial ribs on the peripheral zone of the exumbral surface of the disk, alternating with the same number of prominent marginal lappets. These elevations recall similar structures in the Periphyllidæ and Collaspidæ, but while in these families we have the elevations very broad and the radial depressions appearing as narrow trenches separating the elevations, here the elevations are narrow, forming slight ridges, while the spaces between them are broad, flat, equal to the width of the marginal lappets of the umbrella. The radial elevations on the exumbral surface of the bell recall the coronal sculpturing of the Collaspidæ and Periphyllidæ, and it may be supposed that *Ephyroides* is an ancestral genus connecting the genus *Ephyra* with such genera as *Nauphanta*, *Atolla*, and *Periphylla*.

Specimens of *Ephyroides* were collected by the Albatross at the following localities:

Catalogue numbers.	Stations.	Locality. N. lat.	Locality. W. long.	Depth.
		° ′ ″	° ′ ″	*Fathoms.*
9300	2042	39 33 00	68 26 45	1,555
9319	2044	40 00 30	68 37 20	1,067
9298	2047	40 02 30	68 49 40	389
9294	2051	39 41 00	69 20 20	1,106

Ephyroides rotaformis, sp. nov.

(Plate VII.)

The different specimens of *Ephyroides* were regarded as members of a single species, *E. rotaformis*. Three specimens in the collection were collected from Station 2044, and one from each of the others. None were in the best of condition for a study of specific characters, and the character of the subumbrella was impossible to be made out with any great accuracy. With one exception (Station 2042), the whole medusa was covered with a brownish, coagulated slime, not unlike that found on the surface of many specimens of *Periphylla* (*P. humilis*), which rendered it extremely difficult to study the minute anatomy. The generic characters are, however, well marked on the exumbral surface of the umbrella of all specimens.

The umbrella is flat, discoid, and when seen from the exumbral side appears divided into three zones: (1) Discus centralis (*dis. cent.*); (2) Zona coronalis (*cor.*); (3) Zona marginalis (*mg. lp.*). The diameter in alcohol is about 15^{mm}.

The zona centralis (*dis. cent.*), which corresponds to the central disk of *Atolla et alia*, is circular, about 5^{mm} in diameter. Its surface is smooth and destitute of superficial appendages. No coronal fissure was observed separating the discus centralis from the zona coronalis.

The zona coronalis, (*cor.*) is, like the zona centralis, about 5^{mm} wide, and bears upon its surface a number of radial elevations (*soc.*), which have suggested the name *rotaformis*, "wheel-formed," a resemblance which is striking, shown in a specimen from Station 2042. These elevations vary in number in the different specimens, but are always found in the radius which cuts the marginal fissures separating the marginal lappets. They are simple, rounded, sausage-formed elevations, smooth superficially, ending a short distance from the deepest point of the marginal incision on the peripheral side, and abutting the line of junction of the discus centralis and zona coronalis, on the centripetal extremity. Their length varies slightly in different radii and in different specimens. The resemblance which they impart to this region of the umbrella and that of *Nauphanta* is striking. In all the specimens studied the zona coronalis is extended horizontally, by which the elevations become radial. Homology, when this genius is compared with the most closely related genera, would lead us to believe that these bodies are more vertical, although in *Ephyra* the homologous region is horizontal.

The most peripheral of the three zones is the zone of the marginal lappets, or the zona marginalis. The marginal lappets (*mg. lp.*), as in all Ephyridæ, are prominent and large. Their walls are thin, outlines rounded, twice as long as broad. The marginal lappets are sometimes folded back on the exumbrella, when they lie in the spaces which separate the radial elevations. The marginal lappets (Fig. 2) are long, thin, supported at their base by a pair of gelatinous socles (*mg. soc.*) continuations with the walls of the bell. The tentacles in several cases

were observed hanging from the incision which separates the marginal lappets. It was not observed—on account of the poor preservation of this region of the bell—how many tentacles and how many sense-bodies there are in *Ephyroides*. I think from what I could observe that there are eight tentacles and eight sense-bodies on a specimen with 32 radial socles. This is, however, conjectural, and was not observed, as the figures show. The structure of the subumbral region of the disk is in all cases too distorted to admit of a scientific examination.

Family LINERGIDÆ, Hæckel, 1877.

LINERGES MERCURIUS, Hæckel.

There is no doubt that when the Gulf Stream is more carefully explored *Linerges* will be found in great abundance. I have taken it by thousands in the Straits of Florida, and the Albatross collected many specimens from the Gulf of Mexico and the Caribbean Sea. It also occurs in the Sargasso Sea, at Bermuda, and off Florida.

The different species of *Linerges* recorded by Hæckel seem to me based on doubtful specific characters. Of the bottle full of specimens of *Linerges* from the Gulf of Mexico some have characters of *L. Mercurius*, others of *L. Pegasus*, while there is a complete series of individuals which forms a graded series from one into the other. If the two species are good ones both may be expected in the southern part of the Gulf Stream.

Family AURELIADÆ, L. Agassiz, 1862.

AURELIA FLAVIDULA, Per. et Les.

Catalogue numbers.	Stations.	Locality— N. lat.	Locality— W. long.	Depth.
		° ′ ″	° ′ ″	
9289	2231	38 29 00	73 09 00	Surface.
8302	2253	40 34 30	69 50 45	Do.

These two specimens closely resemble *A. flavidula*, but have very long oral arms, and in the position and size of the "ovarian openings" seem to stand intermediate between *A. marginalis*, Ag., and *A. flavidula*. One of the specimens is an interesting one in having only three oral arms and three ovarian openings.

Family CYANEIDÆ, L. Agassiz, 1862.

CYANEA, sp.?

The bell of a mutilated *Cyanea* is found in the collection. It resembles *C. Arctica*.

Catalogue number.	Station.	Locality—	Depth.
5124	(?)	Locality unknown. Gulf Stream. ?	Surface.

Sub-family STOMOLOPHIDÆ, Hæckel, 1880.

STOMOLOPHUS MELEAGRIS, Ag.

Catalogue number.	Stations.	Locality. N. lat.	Locality. W. long.	Depth.
		° ′ ″	° ′ ″	
6249	2085–88	{ 40 05 00 39 59 15	70 34 45 70 36 30	70 143

Family PELAGIDÆ, Gegenbaur, 1856.

PELAGIA CYANELLA, Per. et Les.

Specimens examined.

Catalogue numbers.	Stations.	Locality.	
9751	950	Off Marthas' Vineyard, S. 79½ M.	
9716	952	Off Martha's Vineyard, S. ¼, E. 87½ M.	
9718	953	Off Martha's Vineyard, S. ½, E. 91½ M.	
		N. lat.	W. long.
		° ′ ″	° ′ ″
4138	1038	39 58 00	70 06 00
8083	2223	37 48 30	69 43 30
8084	2223	37 48 40	69 43 30
9722	....	41 25 00	65 10 00

TRACHYMEDUSÆ (Hæckel emend.) Claus.

Sub-family TAMOYIDÆ, Hæckel, 1877.

TAMOYA, Fritz Müller.

I have seen several specimens of *Tamoya* from the Gulf Stream.

In the collection made by the Albatross there are two specimens referred to this genus taken off Cape Hatteras.

Catalogue number.	Station.	Locality— N. lat.	Locality— W. long.
		° ′ ″	° ′ ″
8473	2289	35 22 50	75 25 00

Family AGLAURIDÆ, L. Agassiz, 1862.

TRACHYNEMA DIGITALE, A. Ag.

Specimens examined.

Station.	Locality.
1026	Off Martha's Vineyard, S. SW. ¼, W. 94½ M.

AGLAURA VITREA, Fewkes.

Aglaura is common along the Florida Keys, and occurs in the latitude of the Bermudas.

NARCOMEDUSÆ, Hæckel, 1877.

HALICREASIDÆ, fam. nov.

HALICREAS, Fewkes, 1882.

(Plate VIII.)

There are several specimens of this most extraordinary genus, some of which are well preserved, from which I am able to add something to what little is at present known of its anatomy. In 1882 (*Bull. Mus. Comp. Zool.*, vol. ix, No. 8), from two specimens collected by the U. S. Fish Commission, I established a new genus and species, to which was then given the name of *Halicreas minimum*. This medusa reoccurs in the collections of 1883, and from them the fragmentary observations then made can now be confirmed and several others added to our limited knowledge of its exceptional anatomy.

Halicreas is recognized by the possession of eight rounded protuberances (*mg. p.*), in many alcoholic specimens bearing rounded tubercles of brownish color, placed on the margins of the disk. From these, tubercles extend radially on the subumbra side towards the center of the disk, like spokes from the rim of a wheel, a corresponding number of radial ribs, which are in some specimens well marked, in others less evident. When seen on the subumbral side in one specimen these spokes (Figs. 1, 2, g.) seem to be glandular. No tentacles in alcoholic specimens, and no proboscis. Eight sausage-shaped or tentacular-formed bodies were observed in one specimen hanging down from the under-side of the umbrella, each arising from a point between the radial ribs not far from the center of the disk. A line passing through the center of the disk and the center of the point of attachment of these structures cuts the margin of the umbrella midway between two bundles of tubercles.

The affinities of *Halicreas* with known genera are probably the nearest to the strange family of Pectyllidæ, Hæckel, and of these it has a distant likeness to the genus *Pectanthis* in some particulars. In *Pectanthis*, however, we have on the bell margin sixteen clusters of small tentacles with sucker extremities, while in *Halicreas* there are only eight marginal tubercles. Moreover, the surface of these tubercles is sometimes covered with small conical teeth, which may in a distant way correspond to the sucker-bearing tentacles of *Pectanthis*. These tubercles in *Halicreas* never bear tentacles nor suckers. There are eight ovaries in *Halicreas*, and the genus has a very thick velum, which is highly muscular and contractile. This velum at times almost completely closes the entrance into the bell cavity.

These and other features ally *Halicreas* in a distant way to the Pectyllidæ, but I know of no family in which the genus can find a legitimate place. In a specimen of *Halicreas*, which is destitute of the tubercles on the eight marginal projections, we find the prominence slightly everhanging the bell-margin, recalling in general structure the marginal lappets of the Ephyridæ. I think this fact, taken in connection with the existence of the number eight, may be found to be a significant one in relation to the affinities of this medusa. In the specimen where there is the closest likeness between the marginal tubercles and the socles of sense-bodies of an Acraspedote medusa, there is a nearer resemblance to the original types of *Halicreas* described in 1882 than in the case of the other specimens. The papillæ on the prominences are, however, not as well marked as in the type and in the last-mentioned examples. This fact is a confusing one, and but for the regularity of the tubercles would lead me to ascribe them to the state of preservation of the specimen. It seems, however, impossible that the "papillæ" are the result of alcoholic contraction, and all these specimens are therefore placed in my old species, *H. minimum*.

HALICREAS MINIMUM, Fewkes.

(Plate VIII.)

The genus and species is represented by several specimens in the collection made by the Albatross. One of these closely resembles the type; the others are doubtfully placed in the same species. In the specimen like the type (Station 2236) the tubercles have inconspicuous papillæ; the remainder have papillæ even more prominent than in the type. In the latter the margin of the bell becomes very much hardened and contracted in alcohol, so that the resemblance to the live medusæ must be very distant.

Specimens examined.

Catalogue numbers.	Stations.	Locality— N. lat.	Locality— W. long.	Depth.
		° ′ ″	° ′ ″	Fathoms.
9284	2034	39 27 10	69 56 20	1,346
9316	2039	38 19 26	68 20 20	2,369
9308	2041	39 22 50	68 25 00	1,608
9297	2042	39 33 00	68 26 45	1,555
....	2202	39 38 00	71 39 45	515
9334	2216	39 47 00	70 30 30	963
8091	2236	39 11 00	72 08 30	636

In addition to this material I have found in the collections of the Blake, made in 1880, a specimen of *Halicreas*, which, if it belongs to the above species, shows many differences from the type. It was found in lat. 39° 25′ 30″ N., long. 70° 58′ 40″ W; depth, 1,394 fathoms.

The bell of several of these specimens is smaller than that of the *H.*

minimum described in 1882, flat, discoidal, about 6mm in diameter; the exumbral surface (Fig. 1) smooth, walls gelatinous, slight convex, white or light-straw colored in alcohol. The marginal prominences (*mg. p.*) have a marked difference from those of the type. In one specimen (Station 2034) the bell as seen from the exumbral surface shows the tips only of the eight marginal prominences. In another (Station 2041) the tubercles are very prominent on the prominences. This also holds true in a majority of the specimens. In one of two specimens from Station 2216 the transparent part of the bell is inflated so that it is almost spherical. This condition is thought to be the result of the contraction of the bell margin.

The region of the bell upon which the tubercles of the margin of the umbrella are best seen is the subumbral (Figs. 2, 3). The tuberculated elevations (*mg. p.*) are invariably eight in number, and are colored light-brown, almost amber-colored in some cases. Individual papillæ are simple, conical elevations, of which there are three or more (generally a regular arrangement) side by side on the bell margin. There is commonly one of these tubercles which is more axially placed than the others on the upper surface of the umbrella. The great degree of hardness attained by these tubercles, as well as the whole umbrella margin, is a noticeable characteristic in several specimens. The marginal prominences are destitute of tentacular appendages, and in the best preserved specimens there was nothing to indicate that they are homologous to similar appendages in some Pectyllidæ. Their homology and function is unknown to me. In all cases the structure of the stomach and the velarium (*vel.*) could not be made out on account of the contracted condition of the specimens. The whole structure of the medusa, as far as known, shows that *Halicreas* belongs somewhere among the Narcomedusæ of Hæckel, as I have already stated in my original description of the genus. It has certain affinities with the family of Pectyllidæ, but differs very greatly from the genera which have been described by Hæckel.

Family SOLMARIDÆ, Hæckel, 1877.

SOLMARIS INCISA, sp. nov.

(Plate IX.)

A medusa closely allied to *Solmaris* is represented in the collection by several specimens. These are at present placed in a new species of *Solmaris*. Some of these specimens are simply fragments, containing, however, the greater part of the umbrella margin; some are in a good state of preservation. I was at first led to suppose, from the resemblance of the margin of the umbrella to the marginal lobes or lappets of certain members of the family of Ephyridæ, that these specimens are close relatives of that family. A study of the other organs, especially a careful

examination of the velarium, shows me the error of such a view as far as the systematic determination of the species goes. It was seen that in almost all cases the velum is broken up into parts resembling marginal lappets, breaking along the lines of the peroniæ, thus giving us structures which closely resemble the marginal lobes of the Acraspeda. Several of the peroniæ are still unbroken in certain specimens, enabling me to observe the anatomy of this region of the disk margin. Although the majority of the specimens have the velarium broken into marginal lappets, the union of these marginal lappets in several instances was thought to prove that the lappets are nominally united in all specimens.

The umbrella is discoid in shape, slightly convex above, flexible in alcohol. The velarium (*vel.*) hangs from the lower outer rim of the disk, and is crossed by a number of vertical ribs (fig. 2, *per.*) connecting with the free edges of the velarium and the tentacular bases. These bodies (peroniæ) are always the lines along which a break occurs when the velarium is divided into the bodies which resemble and are supposed to be homologous with the marginal lappets (*mg. lp.*).

The exumbrella has from 24 to 32 shallow radial depressions (*fos. rad.*) or furrows, found near the periphery. These furrows are separated from each other by the same number of radial, generally more or less polygonal, elevations (*col. sub.*), which lie in the same radii as the tentacles and peroniæ. There are consequently the same number of tentacles as of peroniæ.

Specimens examined.

Catalogue numbers.	Stations.	Locality— N. lat.	Locality— W. long.	Depth.
		° ′ ″	° ′ ″	*Fathoms.*
6251	2094	39 44 30	71 4 00	1,022
6723	2104	38 48 00	72 40 30	991
....	2110	35 12 10	74 57 15	Surface.

The umbrella is flat, discoid, rounded-convex at edges. The vertical thickness of the bell walls at the center of the disk is much less than in the zone of the radial subumbral elevations. Horizontal diameter 50–100mm. On the subumbral side of the disk there is a zone of radial furrows (*fos. rad.*), which begins a short distance from the union of the velarium (*vel.*) with the periphery of the umbrella and extends centripetally 10–15mm from the same. These incisions are shallow trenches in the subumbral side of the umbrella between elevations (*col. sub.*) which lie in that zone. The number of these elevations is equal to that of the tentacles.

Within the disk in a single specimen there is a cavity (*ga.*) formed by a splitting of the gelatinous walls, the rim of which is seen through the wall of the subumbrella, and extends nearly to the internal margin of the zone of radial elevations. This cavity is probably entered by a cen-

tral mouth. Its lower walls are not muscular. The cavity is a simple one, and was not observed to send out radial pouches from its periphery.

The velarium (*vel*) is a collar-shaped structure hanging from the margin of the umbrella, from which position its walls are probaly vertically placed. It is a thin-walled flexible body, crossed by vertical bands (*per.*) (peroniæ), which in one or two instances bind together adjacent marginal lappets. Its free lower edge is poorly preserved in all specimens studied; but in one specimen a structure, which may be true velum, was imperfectly seen. No sense bodies were observed, although they probably exist, and may be looked for on the free margin of the velarium in living specamens. Tentacles are very long, placed at the line of union of the velum and the outer rim of the umbrella. They are inserted at the proximal end of the peroniæ. and as a consequence, in those specimens in which the marginal lappets are formed by the breaking up of the velarium, the point of insertion of the tentacle is at the base of the cleft formed by the rupture. The tentacles are firmly connected with the free margin of the velarium by means of the peroniæ, and are joined to the walls of the umbrella by a conical root (*pero.*) which penetrates the substance of the umbrella. Each basal root or means of union of the tentacle and the disk lies in the same radius as the elevation (*col. sub.*) on the subumbral side of the disk which separates two radial furrows (*fos. rad.*). The radial elevations are therefore similar in position to the tentacular socles of *Atolla*.

The sexual glands were not observed. These bodies, so necessary to distinguish the two genera *Solmaris* and *Solmoneta* Hæck. from each other, are in all cases wanting.

The function of the radial elevations or their corresponding depressions on the under surface of the umbrella is not known. Similar elevations have been described in *Atolla*, *Collaspis*, *Nauphantopsis*, and other genera on the exumbrella, but are not known to exist or are very rare in other medusæ, especially of the Hydroida. An approach in structure to them which can be mentioned among true hydroid gonophores are the radial rows of small tubercles which I have figured on the subumbral surface of the bell of *Polycanna* (*Zygodactyla*) *Grœnlandica*. These structures can hardly be said to be homologous in the two cases. A radical difference between the Trachymedusæ and Narcomedusæ and the Acraspeda has been thought to be the absence of a velum in the latter, and its development in the former. I think in *Solmaris* we have a genus indicating that the homologue of the velum is to be looked for among the Acraspeda in the marginal lappets.

It has been stated by Hæckel that in the genus *Solmaris* the tentacle and peronia are in reality continuous, so that the true insertion of the tentacle is at the extremity of the peronia on the free border of the wall of the velarium. It is true that the peronia is an appendix of the tentacular base, but that the proximal extremity of the tentacle lies at the margin of the umbrella, near its union with the vertical wall of the

velum—the peronia being a projection extending from the tentacular base to the margin of the velarium—is not so evident.* The position and general appearance of the peroniæ in *Solmaris* recall the same structure in *Cunina discoides*, Few. If we regard the tentacles as in reality ending at the margin of the umbrella, and not at the free margin of the velarium in *Solmaris*, it seems probable that the walls of the velarium are homologous with the marginal lappets of the Acraspeda. That the velarium is, in fact, formed by a consolidation of marginal lappets on their edges along the lines of the peroniæ cannot be demonstrated, but it is certainly indicated by the anatomy of *Solmaris*.

An interesting habit of the genus *Linerges*, a medusa which has other hydroid affinities, may be mentioned in considering the homology last spoken of. *Linerges* when at rest carries its marginal lappet folded inward at right angles to the almost vertical walls of the bell. They seem in a measure to perform a like function as the velum of the hydroid gonophore in partially closing the opening into the bell cavity. Suppose in *Linerges* the edges of the marginal lappets thus folded should be united. We should then have a structure homologous to the return of a free hydroid gonophore.

In some other genera, also, as in the younger forms known as Ephyræ, and in certain adults of the family of Ephyridæ, where almost the whole movement of propulsion is produced by the vibration and repeated strokes on the water of the margina lappets, we have a like infolding of these bodies. The probability that an *Ephyra*-like medusa is the ancestral form of the Acraspeda, and the fact that in it motion is accomplished mainly by the movements of the marginal lappets, leads one to expect that in some Trachymedusæ we may look for a like function in an homologous organ. Although in *Solmaris*, both the umbrella and the velarium probably work together in the propulsion of the medusa in many allied genera, *Cunina* and others, the bell walls are sometimes rigid and the velarium and velum are the sole means of propulsion.

HYDROIDA.

The Craspedote medusæ are represented in the collections by a very small number of genera and species.† This scarcity is not wholly due to their small size. Naturally enough, as we have seen, the gonophores of "free hydroids," Trachymedusæ, would be well represented, but the

* Have we not a similar condition in *Turris episcopalis*, where a spur from the tentacle extends along the side of the bell?

† There is little doubt that many of the hydroid medusæ recorded from Charleston, S. C., Beaufort, N. C., Newport, R. I., and elsewhere on our eastern coast, are brought there by the Gulf Stream. Many others from the same localities belong to a strictly littoral fauna. The difficulty of distinguishing the former from the latter has led me, at present, to eliminate both, and to include only those recorded from the Gulf Stream region. When a more complete account of the Gulf Stream medusæ is prepared it will probably embrace a large number of genera of Acalephs, common in the bays and harbors of the eastern coast of the United States.

facies of the deep-sea fauna, as far as known, leads us to suspect that there are few fixed hydroids on the floor of the Gulf Stream which have free medusiform gonophores. We must suppose also that a large number of the deep-sea hydroids, allied as they are to Plumularidæ, have no medusiform gonophores which come to the surface. The number of these medusæ in the Albatross collection examined is very small as compared with the Acraspeda and Trachymedusæ. They are also mostly of large size, which may indicate a cause of their great minority in numbers.

Family TIARIDÆ Haeckel (1877).

TURRIS EPISCOPALIS (Forbes).

Catalogue number.	Station.	Locality— N. lat.	Locality— W. long.
		° ′ ″	° ′ ″
8737	2243	40 10 15	70 26 00

Family CANNOTIDÆ Hæckel (1877).

STAUROPHORA LACINIATA Ag.

Catalogue number.	Station.	Locality— N. lat.	Locality— W. long.
		° ′ ″	° ′ ″
9288	2039	38 19 26	68 20 20

Family incertæ sedis.*

CALYCOPSIS TYPA, Fewkes.

Catalogue number.	Stations.	Locality— N. lat. W. long.
	870	
	924	Off Martha's Vineyard S. ½ W. 83½ M.
	945	Off Martha's Vineyard S. by W. ¾ W. 81⅓ M.
	952	Off Martha's Vineyard S. ¾ E. 87½ M.
9727	936–8??	Off Martha's Vineyard S. by E. ½ E. 100–106½ M.

*Calycopsis is in certain respects allied to the Æquoridæ of Eschscholtz, from which, however, it has many differences. My impression is that it may form a subfamily of the Tiaridæ; but of that I am in considerable doubt.

Family ÆQUORIDÆ Eschscholtz, 1829.

POLYCANNA Hæckel, 1879.

In studying the characters of the Æquoridæ found at Newport a peculiar structure in *Polycanna* (*Zygodactyla*) *Grœnlandica* (?) (Ag.) has presented itself, which, as far as I am aware, has not been observed by others. This character easily distinguished this species, and may even be found to be of generic worth.* On the subumbral side of the umbrella we find between the radical tubes small rounded prominences arranged in rows, a single row between each pair of tubes, which correspond in number with the number of ovarian frills on the chymiferous tubes. The number of these projections varies with the size of the specimen. At Newport we have two species of *Polycanna* (*Zygodactyla* Ag.), one of which has these projections, while a second is destitute of the same.

Among the Æquoridæ collected by the Albatross there are two species of *Mesonema*, † *M. cyaneum* Hæckel, and *M. Bairdii*, sp. nov. There is one species of *Polycanna*, *P. Americana*, sp. nov.

In the two species of *Mesonema* here considered the number of tentacles is less than the number of chymiferous tubes. They are very close to each other structurally, and may be eventually placed in the same species.

Polycanna Americana has ovaries like those of *Polycanna* (*Zygodactyla*) *crassa* (A. Ag.).

POLYCANNA AMERICANA, sp. nov.

There are three specimens closely related to *P. Germanica*, Hæck., and *P. Italica*, Hæck., one of the subgenus, *Crematostoma*, to which is given the name *P. Americana*.‡

Specimen examined.

Catalogue numbers.	Stations.	Locality— N. lat.	Locality— W. long.	Depth.
		° ′ ″	° ′ ″	
9187	2039	33 19 26	68 20 20	Surface.
9302		Unknown.		

The bell is slightly rounded in vertical profile, discoid, with thin gelatinous walls. Diameter of the disk 45^{mm}. Tentacles very long,

*As these structures are not mentioned in the description of *Polycanna* (*Zygodactyla*) *Grœnlandica* by Agassiz, I am unable to say whether this is the same species as his or not. As the tentacles are in a single row in this animal, it cannot, according to Hæckel, be placed in the *Zygodactyla* of Brandt.

† I have here used the term in the restricted sense adopted by Hæckel.

‡ In the preliminary list the generic name *Zygodactyla* is used for this medusa. In Brandt's *Zygodactyla* the tentacles are "biseriata." In *Polycanna* the tentacles are "uniseriata." *P. Grœnlandica* has the tentacles in a single series.

much longer than diameter of bell, equal in number to the chymiferous tubes. Bases swollen into a tentacular bulb. The upper wall of the stomach is almost flat or slightly convex. The ovaries are very numerous, swollen, and hang down as in *Polycanna* (*Zygodactyla*) *crassa*, Hæckel. No knobs between tubes on under side of the umbrella.

Stomach walls rather broad, oval filaments sparse, short and small. This species is easily distinguished from all our Æquoridæ except *P.* (*Zygodactyla*) *crassa* by the numerous swollen ovaries thickly crowded together. Unlike *crassa* it has a single tentacle at the extremity of each tube. The specimens of *P. Americana* which were studied were much smaller and yet had more numerous genitalia than *P. crassa*.

MESONEMA Eschscholtz, 1829.

MESONEMA CYANEUM Hæckel.

There are several other specimens of the family of Æquoridæ, some of which are simple fragments of a central disk or bell-margin, and which belong to a species of *Mesonema*, similar to that to which the name *Zygodactyla cyanea* was given by L. Agassiz.

Unfortunately none of the specimens have the locality indicated, but the bottles in which they are contained are numbered 9303, 9304, 9305, and 9306. These are evidently all the same species, to which may also be referred two other fragments from the following stations:

Catalogue numbers.	Stations.	Locality— N. lat.	Locality— W. long.	Depth.
		° ′ ″	° ′ ″	Fathoms.
9313	2037	38 53 00	69 23 30	1,731
9186	2038	38 30 30	69 08 25	2,033
9303	....	....	....	....
9304	....	....	....	....
9305	....	....	....	....
9306	....	....	....	....

The specimens of *M. cyaneum* are of small size as compared with other *Mesonemæ*, varying from 15–45mm in diameter. The species is easily distinguished from others found in the Gulf Stream by the very great vertical thickness of the central region of the bell and its convex subumbral central protuberance, the relatively great diameter of the stomach, and the small size of the oval tentacles.

The bell is composed of two regions, a central disk which has the shape of a plano-convex, in one instance double-convex lens, and a coronal part, a zone in which lie the radial chymiferous tubes and which carries on its margin the tentacles and other organs. In most of the larger specimens the coronal portion is more or less broken or distorted; in the smaller it is entire. The central disk is flat, slightly convex above, rounded convex below. In none of the specimens is the coronal groove of great depth, although some of them have the separation of

central region and peripheral part well marked, while in all in which the marginal zone is present the division between the central disk and the peripheral zone is not difficult to trace. The convex protuberance on the subumbral side of the disk is homologous with a slighter protuberance in several other Æquoridæ and morphologically the same structure exists in the genus *Orchistoma* and other genera. In *Aurelia flavidula*, as I have elsewhere pointed out, we have a similar although more angular pyramidal projection from the lower side of the umbrella above the mouth opening. It seems not improbable that this projection in *Polycanna*, *Aurelia* and elsewhere is homologous with the gelatinous peduncle of such genera as *Liriope*, *Carmarina*, *Geryonia* and others.

The width of the coronal zone is about equal to the radius of the central disk. The coronal walls are thin, crossed by numerous radial chymiferous tubes very closely set together. Margin of the corona very thin. Tentacles not numerous, but long, flexible, with enlarged bases. Otocysts probably exist, but the poor state of preservation of the specimens does not admit of their examination.

The sexual glands in a few specimens are still preserved. They are small, resembling frilled sacs, each extending the entire length of the radial tubes. There are no rows of tubercles between the chymiferous tubes on the subumbral surface of the umbrella.

Stomach walls are fastened to the periphery of the central disk at the line of separation of the same from the coronal zone. They consist of a thin, wide, more or less folded membrane, with muscles fastened on one edge to the lower floor of the umbrella, while on the other edges are borne many small tentacular oral bodies arranged in a single row, separated from each other by a considerable space on the lips. These bodies are smaller than the same structures, the oral tentacles, in other Æquoridæ known from American waters. The embryonic nature of these bodies arouses the suspicion that this species may be the young of *M. Bairdii*, a description of which follows.

The thickness of the central disk in the specimen, No. 9304, is so great and out of all proportion to that of the corona, while the coronal furrow is in others so well marked, that it may be found that this species may connect the Craspedote and Acraspedote medusæ. We are certainly reminded in the partial differentiation of the central disk and the peripheral corona of the similar relationship in *Atolla*, *Nauphantopsis*, and some others. The differences between these genera and the *Polycannæ*, however, are so great that their resemblances cannot be regarded as of morphological value, for what is known of the development of the European species of *Mesonema* and others indicate their unquestioned hydroid affinities. It, is, however, still an interesting thing to see in this largest of hydroid gonophores an anatomical separation between the central disk and a peripheral corona closely parallel to what we find in undoubted Acraspeda.

MESONEMA BAIRDII, sp. nov.

Specimens examined.

Catalogue numbers.	Stations.	Locality— N. lat.	Locality— W. long.	Depth.
		° ′ ″	° ′ ″	
8018	2204	39 30 30	71 44 30	Surface.
9325	2207	39 35 33	71 31 45	Do.

Disk flat, discoidal, with smooth exumbral surface. No indication in alcoholic specimens of a coronal furrow. Diameter of disk 80–100^{mm}. In one specimen there are twenty-nine tentacles. The tentacles lie on the bell margin, regularly placed at the peripheral terminus of a chymiferous tube. As a rule, between the tubes which end at the bases of a tentacle in this way there are three chymiferous tubes. Tentacular bulb slightly inflated, or globular. Tentacles short, dark-brown color. Between the tentacular bases on the bell margin, rounded bodies, probably marginal sense-bodies, are seen. Excretionary openings not visible. The velum is thin, narrow. The bell margin pigmented of the same color as the tentacles and tentacular bases. Seen from subumbral side, *M. Bairdii* has in one specimen one hundred and sixteen ovaries, extending the whole distance along the same number of chymiferous tubes. Ovaries slightly convoluted from the peripheral subumbral margin to the walls of the stomach about a half of the whole radius of the medusa. They are separated from each other by a smooth portion of the subumbrella, which is destitute of the papillæ described in *Polycanna* (*Zygodactyla*) *Grœnlandica*. In the walls of this region of the subumbrella occur small white (muscular) threads.

The walls of the stomach hang down from the subumbral side of the disk, and are fimbriated at their free end or margin by the characteristic labial tentacles, which are closely crowded together. The number of labial tentacles equal that of the chymiferous tubes. Extensions from the openings of these tubes into the stomach are continued in the form of mesenteric structures, which end in the labial tentacles. These mesenteries are probably folds in the stomach walls. Intermediate between these extensions on the stomach walls are strongly developed muscular fibers joining each pair.

The labial tentacles are so short that they can be with the greatest difficulty brought together to close the aperture of the mouth. The apertures of the chymiferous tubes into the stomach have the form of slit-like openings, which lie between the mesenteric folds on the inner side of the stomach walls. When seen from the subumbral side the slit like channels resemble continuations of the radial tubes.

I dedicate this species, *M. Bairdii*, out of great respect, to Prof. S. F. Baird, of Washington.

SIPHONOPHORA Eschscholtz, 1829.

CALYCOPHORÆ (CALYCOPHORIDÆ Leuckart, 1854).

The Gulf Stream is undoubtedly the home of a number of Calycophores which have never been described. The following are known from this locality: *Diphyes* is represented by two species, as far as known. One of these is *D. formosa*, Few., while the other species is very close to the Mediterranean, *D. acuminata*, Leuck. A *Galeolaria* very similar to *G. aurantiaca* was taken by me at Tortugas, Florida, and there is every probability that this genus is likewise found in our latitudes. It has been recorded from Greenland by Leuckart. I have seen a single *Abyla* from the Gulf Stream which closely recalls the species *pentagona* from Nice. A *Muggiæa* (Chun) is common at Key West, Fla. *Praya** is found at Tortugas, and possibly off Cape Hatteras, North Carolina.

Of monogastric Calycophores, I regard the genus *Diplophysa* taken by me at Newport, as a Gulf-Stream medusa. In the same category also falls *Eudoxia Lessonii*† Hux. *Gleba hippopus*, Forsk., has been found in several localities in the Gulf Stream. A large specimen of *Gleba*, which has certain differences from the Mediterranean species, was captured in 1883 by the Albatross.

GLEBA HIPPOPUS, Forskal.

Specimens examined.

Catalogue number.	Station.	Locality— N. lat.	W. long.
	925	Off Martha's Vineyard.	S. ½ W. 86 miles.
7983	2202	° ′ ″ 39 38 00	° ′ ″ 71 39 45

The second of these specimens is larger than those which I have found in the Mediterranean, but I can detect no specific differences between them.

*When I first mentioned this genus from Florida in a popular account of the Calycophores (*Amer. Nat.*, Aug., 1883), I did not describe it as a new species, but found, to my astonishment, when the article was printed, that the *Praya*, which I have no doubt is a new species, bears the name *Praya blaino* in my list.

†The *Diphyes pusilla*, McCr., and *Eudoxia alata*, McCr., recorded by McCrady from Charleston Harbor, South Carolina, are probably Gulf-Stream Calycophores. I am not able to tell from McCrady's description whether his *E. alata* is the same as *E. Lessonii*, Huxley, or not. His *Diphyes pusilla* cannot be recognized, for he gives no specific description. He suggests the name, and says (Gymophthalmata of Charleston Harbor, p. 72), "I therefore defer the description of this species, which may perhaps properly be called *D. pusilla* to a future time." I am not aware that he ever described it more in detail, and probably the name ought to disappear from our faunal lists.

? CUBOIDES, sp.

A medusa referred to Cuboides was collected by Prof. S. I. Smith, on George's Bank, in 1872, Bache Coll. This is the most northern limit of this genus in the Gulf Stream region. The Albatross collected an unidentified ? *Cuboides* and a ? *Sphenoides* from the following locality:

Catalogue number.	Station.	Locality— N. lat.	Locality— W. long.	Depth.
		° ′ ″	° ′ ″	*Fathoms.*
9329	2039	38 19 26	68 20 20	2, 369

MUGGIÆA KOCHII? Chun.

The genus *Muggiæa* as limited by Dr. Chun occurs in the Gulf Stream, although not collected by the Albatross, or at least not represented in the collection sent me. I have seen specimens of this genus in the neighborhood of Key West, Fla., and still others collected by a friend off Nantucket. It also occurs at Beaufort, N. C. It closely resembles the *M. Kochii* of Trieste.

PHYSOPHORÆ (PHYSOPHORIDÆ, Auct.)

There are several genera of Physophoræ,* exclusive of the Rhizophysidæ and *Physalia*, found in the Gulf Stream. They are as follows:

STEPHANOMIA, M. E. (FORSKALIA, Koll), ATLANTICA, Fewkes.

Tortugas, Florida, Bermudas.

AGALMA OKENII,† Esch.

Tortugas, Florida, Bermudas.

The *Agalma papillosum*, Few., is possibly the young of this species.

(AGALMA ELEGANS, Few.)

The bottle in which a specimen of this species is found is labeled "Gulf Stream." (*Bull. Mus. Comp. Zool.*, vol. ix, No. 8.) It is doubtful whether *elegans*, which is a boreal species, ever gets far south in the Gulf Stream.

A. elegans, Few., is probably one of the "forms" described by Sars as *Agalmopsis elegans*. The question of its generic name resolves itself into whether *A. Okenii*, Esch., is specifically different or generically the same as *A. elegans*, Few. As an expression of individual opinion the writer regards them as generically identical. The main differences are

* Fragments of a member of the family of Agalmidæ are found from Stations 2175, 2210, and 2235. The genus could not be recognized.

† *Crystallodes rigidum*, Hæck, *Crystallomia*, Dana, and *Agalma breve*, Hux., are regarded as synonyms of *A. Okenii*, Esch.

as follows: *A. Okenii* has a rigid, untwisted axis (polyp-stem), thick covering scales, the distal (unattached edges) formed of faces, which form the sides of the animal below the nectocalices; horn-shaped continuations of the cavity of nectocalyx into the prolongations which embrace the stem. *A. elegans* has flexible stem (twisted), side of the animal below the nectocalices formed by the upper faces of the thin covering scales. No horn-shaped diverticula from cavity of the nectocalyx. If there is formed a new generic name it should not be made for *A. Okenii*, but for *A. elegans* or *Agalmopsis elegans*, Sars (one form). I cannot accept, therefore, Hæckel's new name, *Crystallodes*. If a new name is sought for (*Agalma*, Leuck, mihi) *Agalmopsis*, Sars (one form), it cannot be *Agalmopsis*, since the "first form" of Sars is not *Agalma* in the sense used by Eschscholtz, but a different medusa. *Stephanomia*, Hux., is the first form of *Agalmopsis*, Sars. The question is reduced to this consideration: Is *Agalma Okenii* and *A. elegans* ("one form," Sars, mihi) generically distinct? If they are, a new generic name must be given to *A. elegans*. If *Agalmopsis* is adopted for it, the "first form," Sars, is eliminated and is without name. Huxley says that his *Stephanomia* is generically the same as Sars's first form. I have thought the best way out of the complication is to let *Agalmopsis* stand for Sars's "first form." *Agalma* for another (*Agalma*, mihi), *Stephanomia*, M. E., for the medusa described by Kölliker as *Forskalia*. If the characters of *A. elegans* and *A. Okenii* are generic, a new name, *Agalmoides*, may be proposed for *Agalma Sarsii*, *Agalma elegans*, Few., and *Agalmopsis elegans* ("one form"), Sars. In the present paper these are all regarded as generically identical. *Nanomia cara*, A. Ag., is regarded as the same as the "first form" of Sars and may be called *Agalmopsis carum*.

AGALMOPSIS FRAGILE,* Fewkes.

Key West, Florida.

ATHORYBIA FORMOSA, Fewkes.

Tortugas, Florida.

HALIPHYTA MAGNIFICA, Fewkes.

Catalogue number.	Station.	Locality— N. lat.	W. long.	Depth.
	953	Off Martha's Vineyard, S. ½ E.	91½ miles.	Surface.

APOLEMIA, sp. (provisional).

Off Block Island. U. S. F. Com., 1880.

* By an error written GRACILE on p. 266, Bull. Mus. Comp. Zool., vol. ix, No. 7.

PNEUMATOPHORÆ (PNEUMATOPHORIDÆ, Chun).

Family PHYSALIADÆ, Brandt, 1835.

The Physaliadæ are represented in the Gulf Stream as elsewhere by the single genus, *Physalia*. The species is very common and is probably *P. Arethusa*, Til. The species is widely distributed in all parts of the Gulf Stream.

Family RHIZOPHYSIDÆ, Auct.

There are two genera of this family, *Rhizophysa** and *Pterophysa* gen. nov. The former genus has four species, *R. filiformis*,† Lam., *R. Eysenhardtii*, Geg., *R. gracilis*, Few., and *R. uvaria*, sp. nov. *Pterophysa* has a single species, *P. grandis*, sp. nov. There is also a fragment of a new ? *Rhizophysa* with a gigantic float.

Many fragments of genera of Rhizophysidæ, which could not be determined, were sent to me for identification as found on the dredge rope used by the Albatross. Among these are possible relatives of Studer's, *R. conifera*, but they were too fragmentary for identification. The indications are that the family of Rhizophysidæ will be found to be represented in pelagic faunas by a great number of new genera and species, although alcoholic material thus far preserved is in a most unsatisfactory condition for good diagnoses of the undoubtedly new species which have been collected. It is only on living specimens that many of the minor specific differences, characteristic of the different members of the genus, can be observed. These characters are commonly lost or destroyed in the preservation of the animal in alcohol. The polypites of my new genus, *Pterophysa*, have such an extraordinary structure that even from a specimen shrunken and distorted by the alcohol, I think myself justified in regarding it a new genus and describing it as such. A species of *Rhizophysa*, very different from any yet described, is also well enough marked to merit a new name, *R. uvaria*.

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* Specimens of a species of *Rhizophysa* were collected by the Blake at Station 147, St. Kitts, depth 250 fathoms. I have examined these specimens and find them to consist of a large number of fragments, mostly gigantic polypites, with one extremity colored a dark purple, while the greater part of the same organ is white or pink flesh colored. The species of *Rhizophysa*, to which these fragments belong, is unknown to me.

† Studer (*Zeit. f. wiss. Zool.*, Bd. xxxi) says, "Erstere (*R. filiformis*) in Mittelmeer häufig beobachtet, scheint eine weite Verbreitung zu haben, wenn die von Huxley citirte Art mit *R. filiformis* identisch ist, sie stammt aus dem Nordatlantischen Ocean." The species recorded by Huxley is not *filiformis* but *Eysenhardtii*, and he observed it in the *Indian Ocean*. *R. filiformis*, as Studer says, occurs in the Atlantic, as I have found it at Key West, Fla., and at the Bermudas.

RHIZOPHYSA UVARIA, sp. nov.

A single specimen of a new and characteristic *Rhizophysa* was taken on the surface at Station 2038.

Catalogue number.	Station.	Locality— N. lat.	Locality— W. long.
		° ′ ″	° ′ ″
9287	2038	38 30 30	69 08 25

The float pear-shaped, pointed at apex, with zone of dark pigment. Length, 5mm; diameter, 3mm. Apical opening present. Air sac with bodies in cavity hanging from under side within the float as in *R. filiformis*. Stem short, probably broken, the proximal portion alone remaining.

At the junction of the stem and float we find, as in *Pterophysa*, a cluster of half-developed polypites, at the base of which is a botryoidal cluster of gonophores (?). Below the first cluster of polypites there is a smooth portion of the stem, and then another cluster of polypites arising from a somewhat thickened base. In the second cluster of polypites the basal organs near the point from which these organs arise resembles closely the gonophores figured by Studer* in *R. inermis*. Below the second cluster of polypites we have a portion of the stem still remaining, but with the distal end broken off, showing the same smooth character as the section of the axis between the first and second cluster. In *R. inermis*, Studer, we have the same condition, although in this species a single polypite arises from the vicinity of the gonophores, while the continuation of the stem bears polypites without gonophores. There is, moreover, in *R. inermis* nothing corresponding to the proximal cluster of undeveloped polypites and gonophores as I have described them in *R. uvaria*.

The individual polypites of *R. uvaria* resemble those of *inermis* in the structure of the distal extremity, in which is placed the mouth opening where a small button-shaped end is slightly constricted from the polypite. There are no tentacles in the single specimen studied. No ptera or wing-like appendages on polypites.

The characteristic structure of this *Rhizophysa*, by which it is distinguished from all others, is the grouping of the polypites and gonophores into bundles at intervals along the axis and the want of tentacles. We have here something similar to the arrangement of these structures in the well-known *Apolemia uvaria*, except that in *R. uvaria* nectocalices, bracts, and similar structures are not developed. The sexual bodies are here grouped at the bases of the polypites, as in the species *R. gracilis*, Few., from the Florida Keys.

There are several features in *R. uvaria* recalling *R. inermis* and marked

* *Zeit. f. wiss. Zool.*, Bd. xxxi, Taf. I, Fig. 3.

differences. The very great disparity in size of the two strikes one at first glance. Studer says that the stem of *inermis* is 18^{cm} in length, and the diameter of the float is 1^{cm}. These measurements for the length of the stem may not be different from the dimensions of a complete axis of *uvaria*, but the diameter of the stem and float is much larger in *inermis* than in *uvaria*.

RHIZOPHYSA, sp.

(*Gigantic float.*)

In a fragment of the float and stem of an unknown *Rhizophysa*, the diameter of the float is 1^{mm} and its length 3^{mm}. This is, I think, the largest float of a Physophore, next to that of *Physalia*, *Angela*, and *Angelopsis*, which has yet been recorded. It is unfortunate that the essential organs, polypites and tentacles, of this gigantic *Rhizophysa* are wanting, and I am unable to tell to what species it belongs. It has at the base of the float, at its junction with the stem, a small cluster of half-developed bodies which resemble polypites.

Catalogue number.	Station.	Locality— N. lat.	Locality— W. long.	Depth.
		° ′ ″	° ′ ″	*Fathoms.*
8085	2224	36 16 30	68 21 00	2,574

PTEROPHYSA, gen. nov.

(Plate X.)

Two specimens of Rhizophysidæ, taken from the "dredge rope" at Station 2227, are referred to a new genus, *Pterophysa*.

Catalogue number.	Station.	Locality— N. lat.	Locality— W. long.	Depth.
		° ′ ″	° ′ ″	*Fathoms.*
8086	2227	36 55 23	71 55 00	2,109

This genus, with a general likeness to *Rhizophysa*, is characterized by the existence on the polypites of two longitudinal wings,* which extend

* Studer (*op. cit.*) first described these wings (pt.) in his species of *Rhizophysa*, called *conifera*. He says of them: "Im hinteren Magenabschnitt (Fig. 17) fangen zwei muskulöse solide Leisten, eine dorsale und eine ventrale, sich zu bilden an, die sich nun auf den Basaltheil des Polypen, als flügelförmige Haftbänder fortsetzen und an den Stamm sich anheften (Fig. 18). Diese Bänder bestehen aus einem soliden Gallertkern, einer Fortsetzung des Mesoderms, der am Rande zahlreiche Ausläufer in das Ectoderm sendet, woran sich die Längsmuskelfasern, wie am Stamm festsetzen."

I cannot find any function suggested for these bands, and I am also in doubt as to the purpose of the dendritic bodies on their free margin in *conifera*. There are homologous structures in the cross-sections of a *Bathyphysa* "polyp," as shown in Plate II, Figs. 32, 33 of Studer's paper.

from one end to the other of this structure. These bands are regarded of generic worth. The depth at which this genus, as well as other supposed deep-sea Rhizophysidæ taken from "dredge ropes," has been recorded, does not necessarily conform to that assigned to the station. The fact that they are found clinging to the rope may mean that they come from any depth less than the sounding. The great relative size of the float of most known species of Rhizophysidæ, as compared with that of other Physophoræ, would seem to imply that *Rhizophysa*, like its relative *Physalia*, is a surface genus. In *R. Eysenhardtii*, Geg., a species which I have taken at the Bermudas on the surface of the water, the relative size of the float is very great. The same is true of the supposed deep-sea species described by Studer.

The habit of clinging to a foreign body, as a rope of the dredge when it is drawn through the water, is exemplified in *R. Eysenhardtii*, where the tentacles must almost be torn from their hold before they loose themselves from their connection with a foreign body. In the last-mentioned species this power is lodged in the tentacles and their branches, but in the new genus *Pterophysa* it is possible that additional structures on the polypites, specially adapted for that function, have been added to increase this prehensile power. These structures are the lateral wings (ptera)*
which characterize the polypites of this genus.

The stem and the various appendages of *Pterophysa* are found to be so closely twisted together that it is hopeless to endeavor to uncoil it. Consequently the general outlines of the body are difficult to make out. Many of the polypites, although broken from their attachments, are in good condition.

PTEROPHYSA GRANDIS, sp. nov.

(Plate X, Figs. 1, 2, and 3.)

The float is oval, oblong, 10^{mm} in longer, 5^{mm} in shorter, diameter. At its apex is an indication of the pigmental zone, and a well marked opening, closed by a sphincter muscle, is seen in one specimen. The form of the float and its relation to the axis indicates that, like the species *R. Eysenhardtii*, *Pterophysa*, carries the longer axis of the float vertical

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* In a cross-section of a *Rhizophysa* (*R. conifera*) polypites figured by Th. Studer *op. cit.* Pl. II, Fig. 17, two structures are figured, which are probably the same as the wings of *Pterophysa*. They are not represented in Pl. I, Fig. 4, where the polypite of *R. conifera* is figured. I do not at present understand how a cross-section of the polypite of *conifera* (Pl. I, Fig. 4) can give the strange structure shown in Pl. II, Fig. 18. In the latter figure, which is a "Querschnitt durch den Basaltheil eines Polypen von *R. conifera*," we have structures which resemble ptera, but are much wider than in *Pterophysa*, and bear fringed structures on their edges. Although these structures are four or five times the diameter of the "polyp", in Pl. I, Fig. 4 ("Polyp von *Rhizophysa conifera* mit contrahirtem Magentheil") they are unrepresented. *R. conifera* probably belongs in my genus, *Pterophysa*, on account of the possession of these bands.

instead of horizontal in floating. Its size implies that the animal comes to the surface of the water. At the base of the float, where it narrows into the stem, there arises a cluster of undeveloped flask-like bodies, resembling polypites closely crowded together. In this cluster are young polypites (?) of all ages, but none were observed to have tentacles. The polypites are flask-shaped, oblong bodies, the largest bearing (?) two wings or muscular expansions, one on each side (?) characteristic of the genus. In the smaller specimen of *Pterophysa*, in which the float and axis are present, a little cluster of half-developed polypites below the float is much better preserved than in the larger. In this specimen the axis is very much twisted, and it is impossible to estimate its length with any degree of accuracy, although, judging from the size of the contracted stem of *Rhizophysa filiformis* in alchohol in comparison with the same when alive, the axis of *Pterophysa* must be several feet in length.

In the larger specimens of *Pterophysa*, on the other hand, although the stem is hopelessly twisted, many of the polypites are still attached, and several clusters of sexual organs can be seen. It is in this specimen that the characters of the polypite peculiar to the genus are best seen. Many of the polypites, however, are broken from their attachment to the stem, and the arrangement of these bodies on the axis is very difficult to determine. While the stem of *Pterophysa* becomes tough and opaque in alcohol, the more delicate polypites are more transparent, and easily break off from their attachments. In the bottle in which the *Pterophysa* is preserved there are large numbers of these bodies which have fallen from the stem. They (*pyt.*) invariably have a curved, in profile crescent shape, whether attached to the stem or broken from it. If we examine an individual polypite, we find that the walls on one side are thicker than on the other, and at the same time more muscular, while from each side* there arises (one on each side) a loose muscular flap or wing (*pt.*) to which is given the name pteron. The distance between the two ptera on the concave side of the polypite does not measure more than the third of the whole circumference of the polypite, while the elevation of the ptera above the surface of the polypite, or its width, is less than one-half the distance. The ptera extend from proximal (*a*) to distal extremity of the polypite, and appear almost wholly made up of strong muscular fibers. The polypites are invariably so coiled that the ptera face the concave surface of the organ from which they arise, or extend in loose folds one on each side of the muscular portion of this structure. The coiled polypites in alcohol have a remote likeness to the larvæ of Coleoptera coiled up for defense. They are coiled, both when they are free, or, as often happens, when they tightly embrace the stem, so that

* The relative position of the wings as compared to the axis could not be observed. The bodies with which I have compared them in *R. conifera*, according to Studer, are dorsal and ventral.

the edges of the two ptera, fitting closely upon the axis of the animal, recall the edges of the foot of a Gasteropod mollusk.*

It is difficult to determine definitely the function of the ptera and the peculiar structure of the polypites of *Pterophysa* unless we study the animal alive. The direction of the coiling by which a muscular surface is brought on the concavity of the polypite, and the appearance of the ptera, suggest that the polypite in *Pterophysa* is specialized into a grasping organ, and that these are sucker-like structures by which it lays hold of a foreign body.

The power of grasping by means of the polypites and tasters is a function not unknown, in a limited degree, among other Siphonophora. Both *R. filiformis* and *R. Eysenhardtii* wind their polypites about a pencil thrust near them, while *Physophora hydrostatica*, Forsk. will, in the same way, grasp a foreign body with its tasters, as one can easily see by worrying them or by placing a pencil in their immediate vicinity. There are, however, in neither of these genera no ptera on the polypites and tasters, as in the genus *Pterophysa*. We can, therefore, conclude that *Pterophysa* has the same or a similar power of grasping in its polypites, and that the modification in the structure of the side of the feeding-stomachs with the two lateral wings point to that function. Winding themselves about a foreign body, it probably fastens itself by means of the sucker-like side of the polypite. In this way we are tempted to suppose that it may even drag itself along from place to place on the floating body to which it has attached itself. By the same specialized region of the polypite it may grasp its food, and it is a suggestive fact in this connection that I was unable to detect any tentacles in either of the specimens of *Pterophysa* which was studied.

ANGELIDÆ, fam. nov.

ANGELOPSIS, gen. nov.

(Plate X, Figs. 4, 5.)

The genus *Angela*, discovered by Rang and figured and described by Lesson, has never been retaken, and nothing has been added to our general knowledge of the genus since the first mention. The statement of Professor Huxley expresses the present condition of our knowledge of *Angela*, as it did twenty-five years ago when the now classic "Oceanic Hydrozoa" was written. He says, "All the author of this genus really knows of it is, he says, derived from a drawing 'Communiqué par M. Rang sans nom et sans reseignements.' Under such circumstances it is hardly worth while quoting his definition." While speculation in regard to *Angela* as defined by Lesson, from the imperfection of our knowledge (it must be acknowledged that Lesson's figure has some value), must neces-

* I was reminded in studying the form and relationship of the ptera to the polypites in *Pterophysa* of similar structures in the modified leaf extremity of *Nephenthes* and other "pitcher plants." The resemblance is a distant one, and pertains only to the lateral appendages to the pitcher-like leaf.

sarily be an unprofitable one, the fact remains that the genus *Physalia* in its systematic position is widely isolated from other Physophores, and it is surprising that the gap between its nearest ally, *Rhizophysa*, and itself is unoccupied.

I believe that the additions to our knowledge in the last years have shown that *Physalia* and *Rhizophysa* are more closely related than the former genus and the Velellidæ and Porpitidæ (*Velella*, *Rataria*, and *Porpita*). I think this is shown by the relative size and position of the float, the anatomy of the sexual organs, and the character of the appendages to the tentacles. It seems to me that the resemblances are so close that they ought to be placed together in a scheme of classification. Additions to our knowledge of the species of *Rhizophysa* confirm me in that belief. Still the gap between the two genera is a great one, and we must earnestly expect from the study of genera which connect them, if such exist, a greater or less modification in our ideas of Siphonophore morphology. *Angela* is a genus whose anatomy would throw much light on this subject, but I had, up to the present, supposed that *Angela* was a mutilated *Physophora*, the float representing the bag-like enlargement of the distal end of the stem from which hang the circle of tasters, sexual bells, and polypites, and that the remnant of the necto-stem was seen in the button-shaped apical prominence figured by Lesson. This interpretation of Lesson's figure leaves much to be desired and signally fails to interpret many structures which he figures. It may provisionally be supposed that *Angela* is a good genus and that later studies will again bring it to light.

Still the gap between *Rhizophysa* and *Physalia* may be filled by the discovery of new genera, and these may or may not be allied to *Angela* as well. Among the medusæ collected by the Albatross is a pair of specimens which are considered the closest allies yet found of *Angela*, and which at the same time have relations with *Physalia* more intimate than any other known genus except the problematical medusa of Rang and Lesson. On account of its supposed affinities it is placed in a new genus of doubtful relationship to which is given the name *Angelopsis*. *Angelopsis* recalls the family of Pectyllidæ and may be found to be a transition form from the latter to the Pneumatophoræ.

ANGELOPSIS GLOBOSA, sp. nov.

(Plate X, Figs. 4, 5.)

Two specimens which are placed in this species are from the following locality:

Catalogue number.	Station.	Locality— N. lat.	Locality— W. long.	Depth.
		° ′ ″	° ′ ″	*Fathoms.*
6565	2105	37 50 00	73 03 50	1,395*

* If my interpretation of organs in this genus is correct it is probably a "surface jelly-fish."

This medusa has a spherical region above which is considered a float, on the under side of which is clustered a number of small bodies resembling tentacles. The former region (*pycy.*) resembles the bell-like body in a medusa; the latter, a clump of tentacles closely massed together, with the form which we might suppose they would have if the entrance to the bell cavity were closed by the velum and tentacles developed over its lower floor. The so-called float is spherical, without apical opening or protuberance, smooth on the outer surface, and without radial elevations. Diameter from 7 to 10^{mm}. The wall of the float is thin, and in the interior is a second thin-walled sac or float, which is supposed to correspond to the pneumatocyst (*pycy.*) of *Rhizophysa*. The inner sac has no opening into the outer, and does not communicate with organs below. It is destitute of appendages. Its cavity (*cav. p.*) occupies the whole interior of the float.

The lower floor of the float is formed of the thickened outer walls which bear the so-called tentacles. The thickened region is found to have a cavity within (*cav. b.*) and to be separated by a muscular floor from another cavity (*cav. l.*) just below the inner air-sac. On the outer walls of this thickened layer (*mm.*), at the point where it joins the thin walls of the outer layer of the float, there are found spherical bag-like structures (*gm.*) of unknown function. These bodies recall in appearance the larger float, from which they hang, and suggest the possibility that they are buds from the outer walls. Whether they are new individuals, peculiar zoöids, or chance swellings I cannot determine. They are found in both specimens, and so closely resemble the larger float that the supposition that they are *new individuals budding from the thickened region* of the bell seems highly probable. The cavity of one of them was found filled with bodies resembling those found on the lower floor.

The whole external surface of the thick walls of the lower hemisphere of the medusa is covered with small clusters of bodies which resemble the gonophores in *Velella* or the sexual clusters of *Physalia*. These clusters have a small axis, from the sides of which hang, in grape-like clusters, small, spherical, and ovate bodies resembling tentacular knobs, fastened by a delicate peduncle to an axis. The appended bodies are of two sizes, large and small; and, through the walls of the latter, radial structures which arise under the peduncle can be seen. All are snugly approximated to the outer wall of the animal, and, in one instance, a small fragment of what appears to be an Echinoderm test (*a*) was firmly grasped by them. No *external opening* into the *cavity* of the muscular base on which they hang was found, although carefully searched for, especially at the lower pole of the medusa. In cutting open one of the small spherical bodies (*gm.*) which arise from the side of the medusa I found it filled with a granular mass, which had some resemblance to the botryoidal clusters on the lower hemisphere of the medusa.

In studying the affinities of *Angelopsis* I was at first led to place it near *Pectyllis* and to compare (*mm.*) the lower thickened wall to a velum very much developed, so that the opening into the bell cavity was closed, and therefore hidden. In that comparison the clusters of grape-like bodies would be the sucker-like tentacles known in the Pectyllidæ. To this interpretation I have these objections: (1) If a bell opening exists it could not be found by continued search. (2) There are several of the knob-like bodies on each style, while in the sucker-armed tentacles of the Pectyllidæ each tentacle has a single sucker. It must be repeated, however, that the observation of the fragment of shell (*a*) in the grasp of these bodies shows that they are grasping organs. (3) There is no radial arrangement of organs, nothing to call a proboscis, and no numerical grouping in the botryoidal organs. (4.) Globular bodies like the "buds" (*gm.*) are unknown in any of the Pectyllidæ. Turned by these considerations to look elsewhere for the allies of *Angelopsis* I could only find them among Physophores like *Physalia*, but even here we meet great difficulties. The upper region of the animal is evidently a float, as its great cavity seems to indicate. The globular bodies (*gm.*) are unknown among Physophores. The thickened wall (*mm.*) may well be homologized with the portion of Physalia from which the polypites, sexual clusters, and tentacles arise, while the botryoidal clusters themselves, on the surface of this structure, represent the tentacles, polypites, and similar organs. Some of these are undoubtedly grasping organs. as the fragment (*a*) mentioned above shows. I do not suppose that my interpretation of these organs is wholly correct, but the affinities of *Angelopsis* seem to be more with *Physalia* and *Angela* than with any known medusæ.* We are reminded, in this difficulty in distinguishing whether the globular body is the bell of a medusa or the float of a Physophore, of a theory propounded by Metschnikoff, and supported on other grounds, that these two structures are in reality morphologically identical.

Family VELELLIDÆ, Eschscholtz, 1829.

VELELLA MUTICA, Bosc.

Velella is common in the Gulf Stream. In the Straits of Florida it is very abundant, while in higher latitudes it is recorded from off Hatteras,

* That there are many very striking differences between the new genus described above and *Angela*, is apparent. It is smaller than *Angela*, has not the apical "mamelonne," "garni de valvules claustrales," nor the "tubes digestifs." There are so many incongruous statements in Lesson's description that one suspects the whole account. About the only things which *Angelopsis* and *Angela* have in common is the very large float, the absence of the axis, and the basal tentacles. The propriety of my new name may be questioned, and it may seem better to form a generic name of different etymology. I have, however, retained in part the name given by Lesson, since this genus seems to me to occupy the place which he supposed *Angela* does, and as he expresses it, "fait le passage des physophores aux physales."

Nantucket, Bermuda, and Newport. I have many new localities for this medusa in the Gulf of Mexico and the Carribbean Sea. A young *Velella* was taken by the Albatross at the following station, north of Florida.

Catalogue number.	Station.	Locality— N. lat.	Locality— W. long.
		° ′ ″	° ′ ″
9291	2100	39 22 00	68 34 30

RATARIA (Young VELELLA ?).

Catalogue number.	Station.	Locality— N. lat.	Locality— W. long.
		° ′ ″	° ′ ″
9323	2100	39 22 00	68 34 30

PORPITA LINNÆANA, Less.

The following locality is the most northern latitude at which this medusa has been found in the Gulf Stream. South of this locality it becomes common.

Catalogue number.	Station.	Locality— N. lat.	Locality— W. long.
		° ′ ″	° ′ ″
9281	2039	38 19 26	68 20 20

CAMBRIDGE, MASS., *April*, 1885.

EXPLANATION OF PLATES.

LETTERING.

a. Anterior.
α. Fragment of Echinoderm test.
cav. Cavity.
cav. b. Cavity inclosed by thick muscular walls.
cav. p. Cavity of float.
col. sub. Subumbral radial elevations.
cor. Corona.
dis. cent. Central disk.
fos. cor. Coronal fossa.
fos. rad. Subumbral radial furrow.
g. Radial elevation on subumbral side of disk.
ga. Stomach.
gm. Globular enlargements (buds ?)
i. cor. Internal corona.
lb. inter. Interradial lobe of stomach.
lb. per. Terradial lobe of stomach.
mg. lp. Marginal lappet.
mg. p. Marginal prominence.
mg. sb. Marginal sense-bodies.
mg. soc. Marginal socle.
mm. Muscular wall of the lower portion of the float, or base upon which the botryordal bodies hang.
mus. cor. e. Musculus coronalis externus.
mus. cor. i. Musculus coronalis internus.
mus. delt. Musculus deltoideus.
oa. Ovary.
or. Mouth.
per. Peronia.
per. o. Basal conical spur of tentacle.
pt. Pteron.
pycy. Pneumatocyst.
pyt. Polypite.
s. Stem.
sb. Marginal sense-body.
soc. Exumbral socle. These socles are probably homologous with the tentacular socles (soc. ta.) and the socles of the sense-bodies (soc. sb.) in *Atolla.*
soc. sb. Socle of marginal sense-body.
soc. ta. Socle of marginal tentacle.
som. Somatocyst.
sr. Sulcus radialis.
ta. Tentacle.
v. Velarium.

PLATE I.

Atolla Bairdii, from exumbral surface.

PLATE II.

The same from the subumbral side. Five marginal socles of sense-bodies on left side, with marginal lappets inward.

PLATE III.

Fig. 1. *Atolla Bairdii*, lateral view with exumbral surface thrown into perspective.
Fig. 2. Three tentacular socles and two rhopalia from the corona, showing their relation to the coronal furrow.

PLATE IV.

Atolla Verrillii, from exumbral side.

PLATE V.

Fig. 1. *A*. Quadrant of *A. Verrillii*, from subumbral side, with organs entire. *B*. Quadrant from exumbral side. *C*. Quadrant from subumbral side (Interradial), ovaries removed. *D*. Quadrant from subumbral side (Perradial), ovaries removed.
When the quadrants are entire there are twenty-two tentacles.

PLATE VI.

Fig. 1. *Nauphantopsis Diomedeæ*, lateral view.
Fig. 2. The same, exumbral view.

PLATE VII.

Fig. 1. *Ephyroides rotaformis*, exumbral surface.
Fig. 2. View of three exumbral socles (*soc.*), and three marginal lappets from exumbral surface.

PLATE VIII.

Fig. 1. *Halicreas minimum*, exumbral surface.
Fig. 2. The same, subumbral surface.
Fig. 3. The same, with more thickly tuberculated marginal prominence.
Fig. 4. Side view of *Halicreas*.

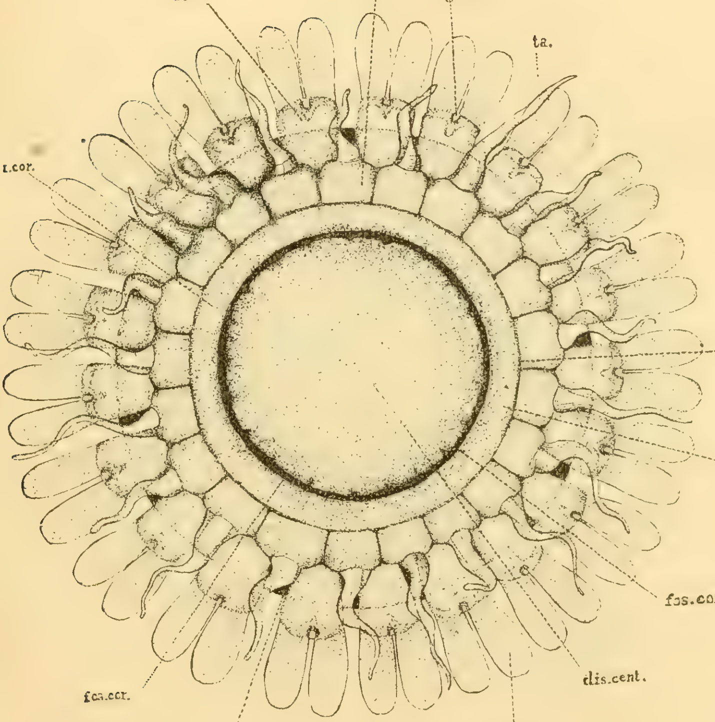
PLATE IX.

Fig. 1. *Solmaris incisa*, life size, divided into four quadrants, of which (1) shows the disk from above, with velariam entire and turned downward; (2, 4) the disk from above, with the velarium broken up into "marginal lappets" (*mg. lp.*); (3) bell from below (subumbral).

PLATE X.

Fig. 1. Polypite of *Pterophysa grandis*.
Fig. 2. The same, from convex side.
Fig. 3. The same, from concave side, slightly inclined to observer.
Fig. 4. *Angelopsis globosa*, lateral view.
Fig. 5. Section of last, showing interior.
Fig. 6. Stem (portion) of *Rhizophysa uvaria*, with float.

The drawings of all the figures were made from nature by the author.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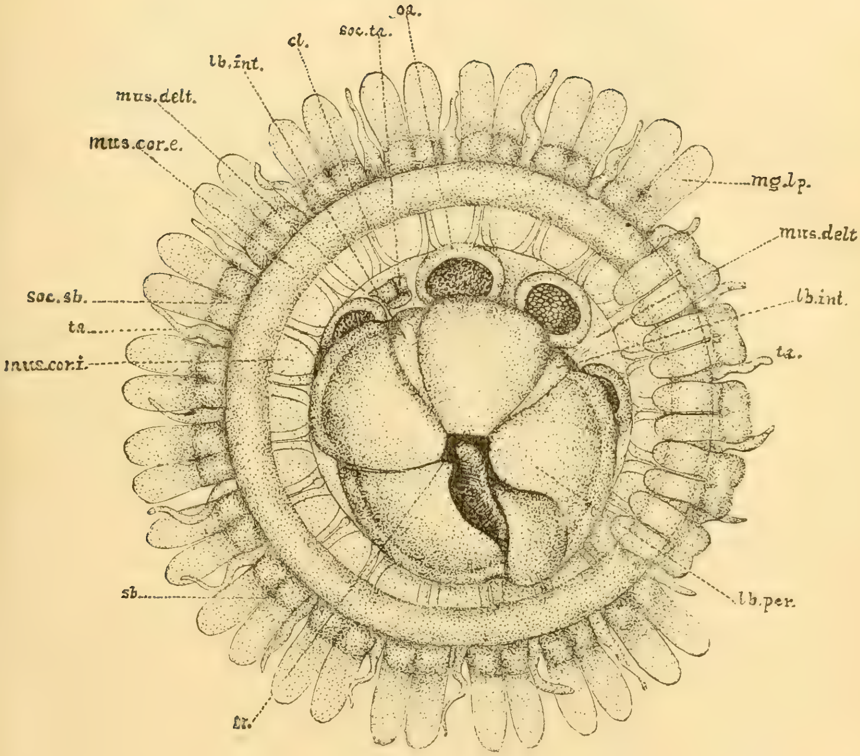
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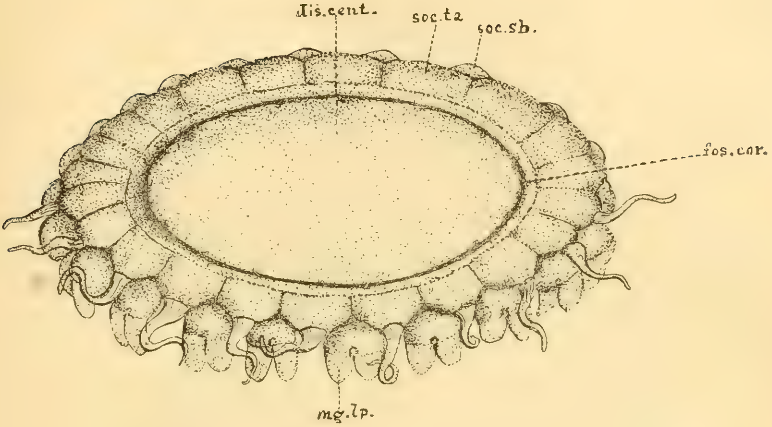
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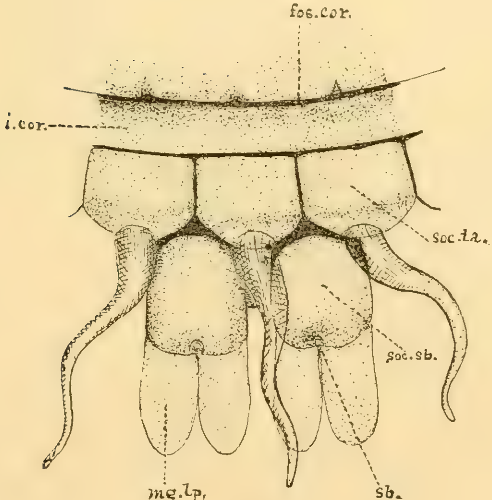
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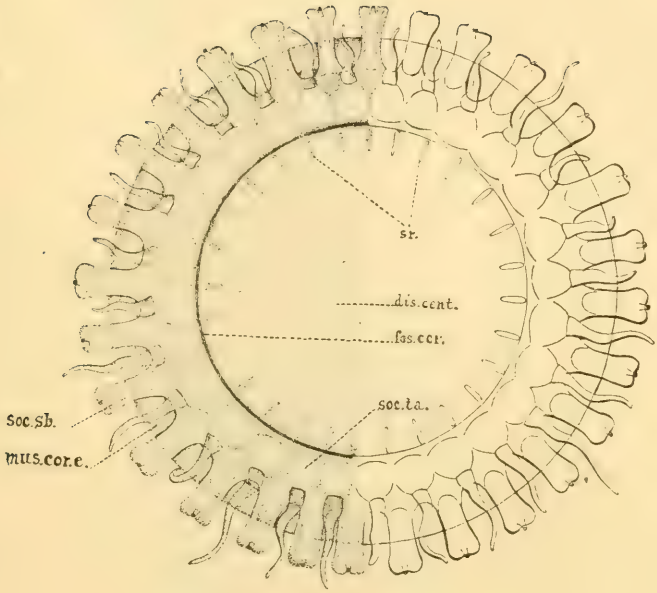
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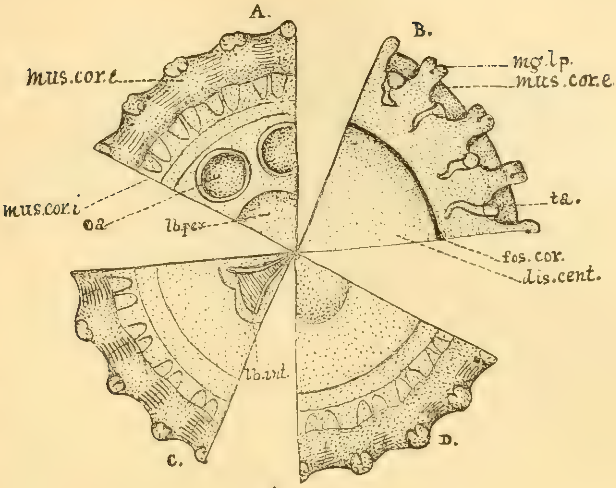
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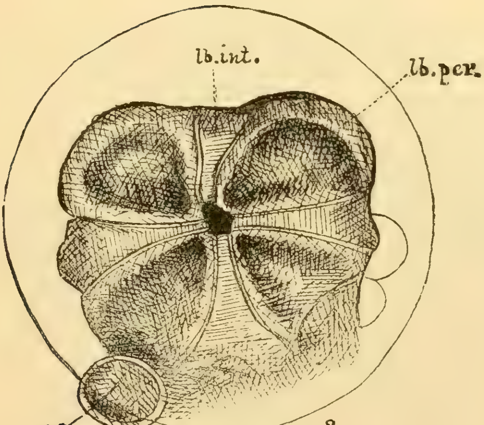
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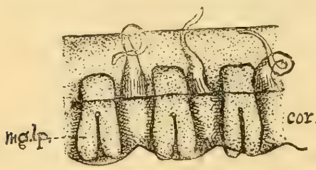
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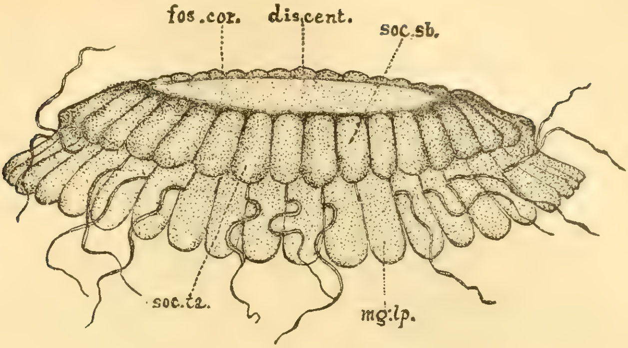
cor.

3.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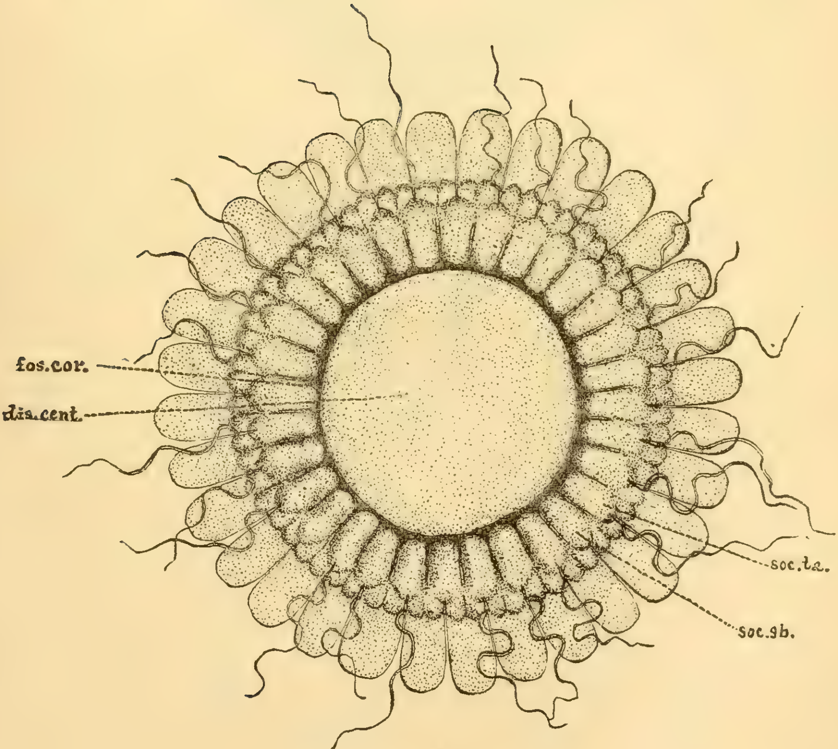
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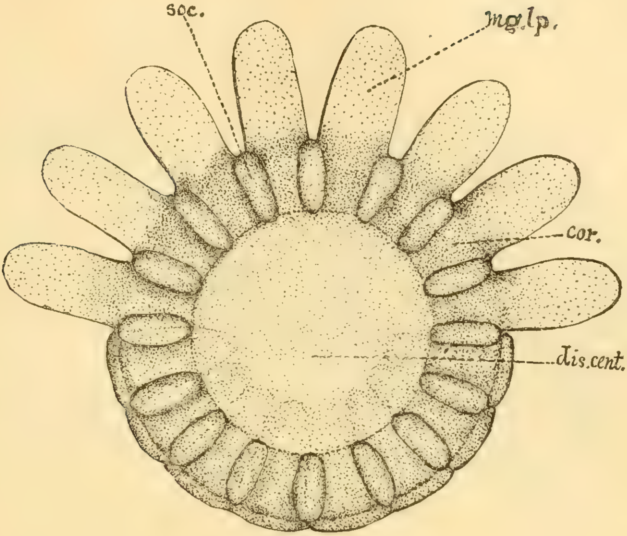

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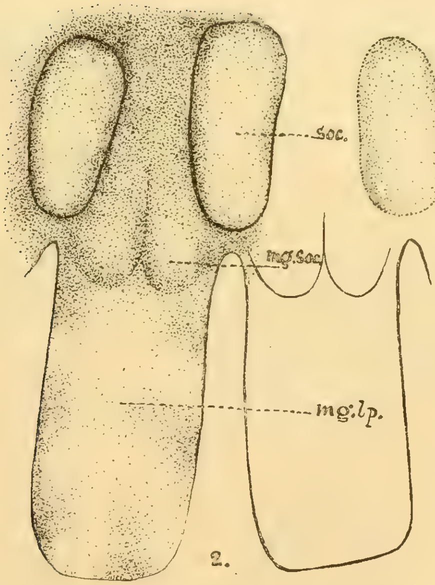

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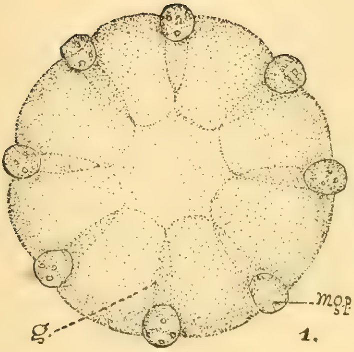

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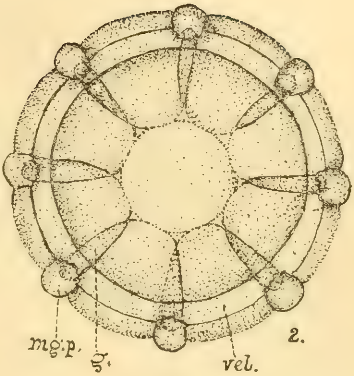

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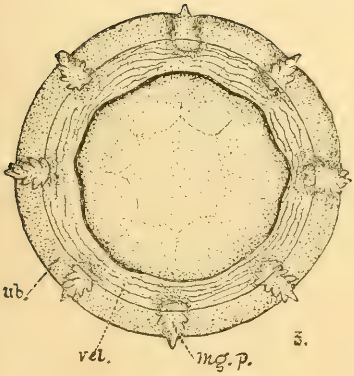

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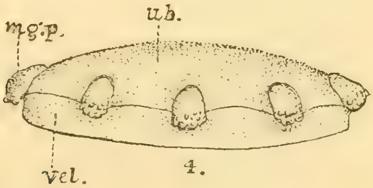

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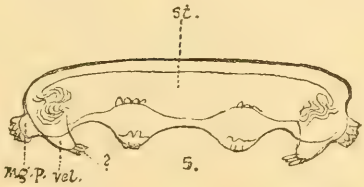

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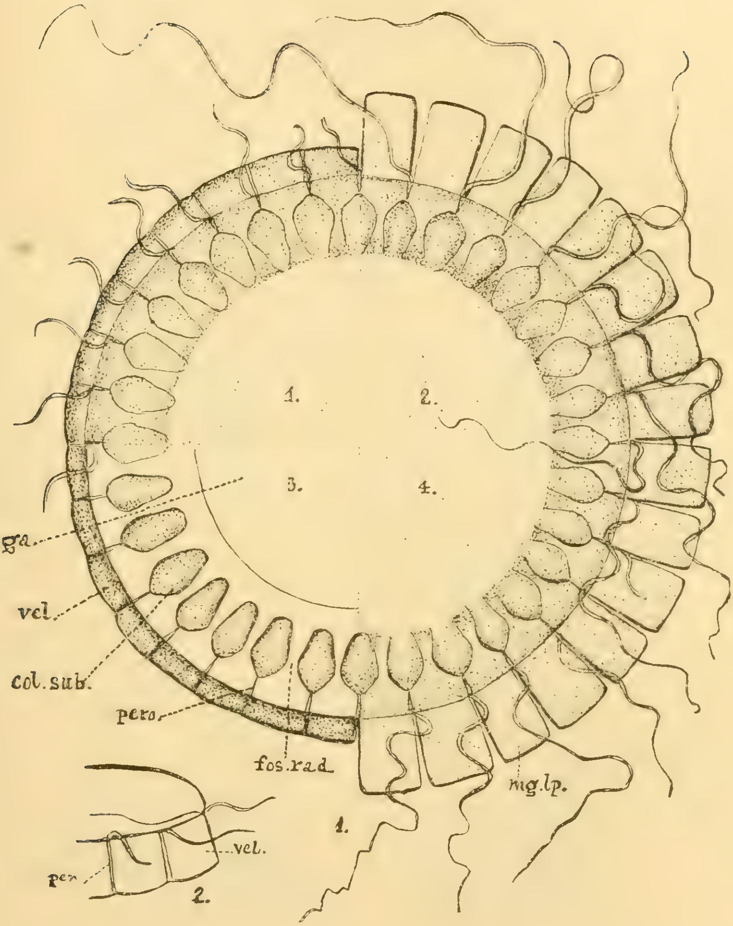
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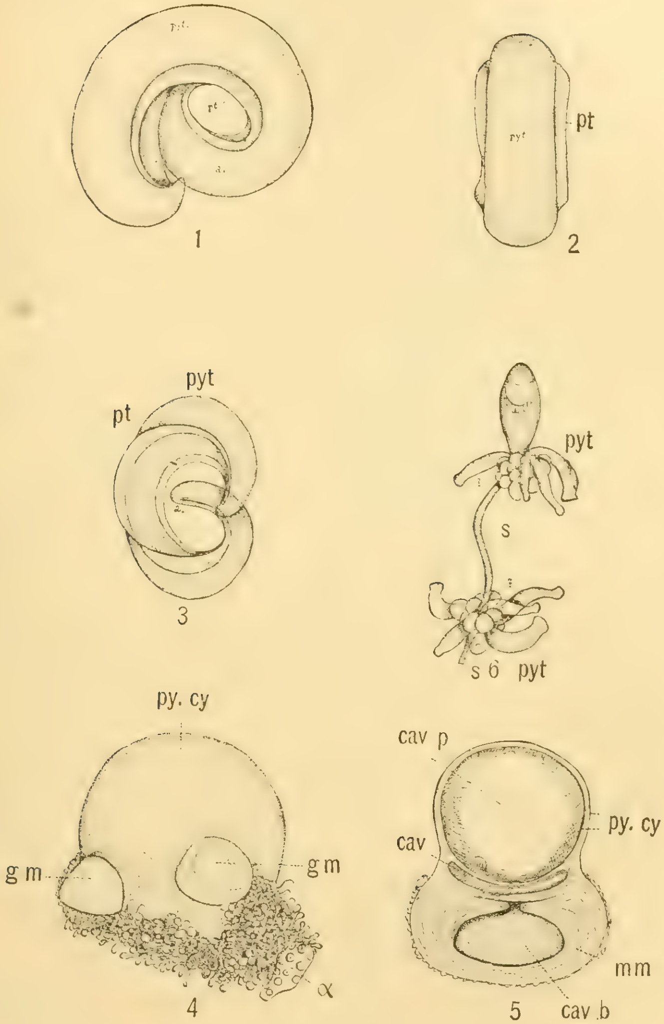
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XXXVII.—ON THE ORIGIN OF HETEROCERCY AND THE EVOLUTION OF THE FINS AND FIN-RAYS OF FISHES.

BY JOHN A. RYDER.

"Alles Gewordene, im Reiche der Natur, wie in der Geschichte, ist nur durch sein Werden zu begreifen und die Entwickelungsgeschichte ist in diesem Sinn für den Naturforscher vollkommen dasselbe, was die Weltgeschichte für die Menschheit."—BRUCH: *Wirbeltheorie des Schädels.*

INTRODUCTORY.

The following paper is the outgrowth of scattered observations made during the last four years on the development of fishes, and in order to make the results available, it has been thought best to bring them together in a permanent form. The portions which do not seem to the reader to bear directly upon the theory of the fins, which it has been sought to establish, may be regarded merely as collateral or supplementary, and are introduced to further illustrate the kinetic or mechanical hypotheses of evolution of structural differentiation through the voluntary or habitual movements of animals, which the author has previously advocated in other publications in relation to other sets of organs. Abstracts of some of the special results here published in full have already appeared in another place.*

The views here put forth in relation to the way in which the morphological differentiation of the fins of fishes has occurred, rest partly upon facts of my own observation, but I must express my great indebtedness to the researches of L. and A. Agassiz, especially the latter, and Vogt, Dohrn, Th. Lotz, Balfour, W. N. Parker, Huxley, and Kölliker, whose labors have prepared the way for me to co-ordinate many of the known facts and establish doctrines founded upon the theory of ontogeny, respecting the origin and differentiation of the fins, both paired and unpaired. Acknowledgments are also due from me to Professor Baird for the loan of valuable material from the collections of the National Museum, and to Dr. Bean and Mr. G. Brown Goode, who have called my attention to specimens which would otherwise have been overlooked. Finally, I must express my thanks to Professor Gill for the interest he has shown in calling my attention to extremely specialized types of fins in rare or aberrant forms, and for aid in obtaining information upon the literature of the subject.

*1. An outline of a theory of the development of the unpaired fins of fishes, Am. Naturalist, 1885, pp. 90-97.

2. The development of the rays of osseous fishes, Am. Naturalist, 1885, pp. 200-204.

I.—Terminology.

The names applied by different authors to the initial or larval stages of development of the Teleostean tail differ so greatly in their etymologies and their implications, that it is desirable not only to consider the terms hitherto proposed, but also, in order to be more precise, to add certain ones in order to designate phases of development and conditions of structure which have not been heretofore recognized.

The term *archicercy* and its adjective form *archicercal* will therefore be introduced here in order to define the cylindroidal, worm-like caudal end of Ichthyopsidous larvæ before they acquire median fin-folds.

Jeffries Wyman* in 1864 proposed the term *protocercal* to designate the larval condition of the tail of *Raia* when it had acquired median fin-folds. This term seems to imply that this primary form of the tail of larval fishes precedes in the order of time the subsequent conditions, or that it is the first stage of the evolution of the caudal fin. This term was adopted in the same sense by Wilder in his article, "Gar-pikes, old and young," Popular Science Monthly, XI, 192, 1877, where the condition of the tail of the larvæ of *Lepidosteus* was considered.

A. Agassiz † in 1877 considered the subject anew, and in an essay *On the development of the tail*, which is of great value from an embryological standpoint, proposed the term *leptocardial* for the same condition implied by the word *protocercal*, for the reason that young fishes in this stage showed a uniform and continuous development of the median fin-fold over the end of the body, very similar to the condition which is permanently characteristic of the vertical fins of the Leptocardians. If it is true, however, that the median fin-folds of the latter contain rudimentary cartilaginous basal rays or their representatives, the comparison and the choice of the name are slightly at fault, and is really not as appropriate as the one previously proposed by Wyman. Inasmuch, therefore, as the terms *diphycercal*, *heterocercal*, &c., refer to definitely understood structural conditions of the tail in adult forms, it seems not inappropriate, undesirable as it is to add another to the number of existing terms, to propose a new one to designate the symmetrical, eradiate condition of the continuous or discontinuous median fin-fold or folds of larval fishes, and which, like the terms applied to the description of the tail of the adult, shall have reference solely to structure and not imply anything as to an hypothetical parallelism with a lower type, nor anything respecting a supposed order of evolution. Such a term it is not difficult to choose, if we bear in mind that the earliest form of the caudal fin is little or nothing more than a fold of the skin which is composed entirely at first of epiblastic tissue, and that it does not include rays even of the most rudimentary kind. The term, therefore, which

* Observations on the development of *Raia batis*, Mem. Amer. Acad. Arts and Sciences, 1864.

† On the young stages of Osseous Fishes, Proc. Am. Acad. Arts and Sciences, XIII, p. 123.

will not only describe this larval condition, but also be in harmony with the terms descriptive of the adult tail, will be, *lophocercal* and its derivative, *lophocercy*, which will imply that the membranous tail is formed merely of a fold of skin or epiblast, continuous with that on the axial part of the tail, and that the inner surfaces of this fold are more or less nearly in contact.

The next term will apply to the next stage of development as indicated by the most undifferentiated median fin-system as seen in *Ceratodus*, *Protopterus*, &c. *Diphycercal* and *diphycercy* will therefore imply a condition in which the end of the axial column bears not only hypural, but also epural intermediary pieces which support rays, as defined by Huxley. *Diphycercy* may coexist with *heterocercy*, and does not completely vanish until all of the rays of the caudal are supported by hypural spines only, or when an ideal *hypocercal* condition is attained.

The next stage of caudal development is attained in the *heterocercal* condition, when the hinder end of the vertebral axis is flexed upwards, and the words *heterocercal* and *heterocercy* throughout the present paper will invariably mean that such an upbending has happened, even if it involves the modification of but a single terminal vertebra.

The words *homocercal* and *homocercy* will merely express the epaxial and hypaxial symmetry presented by the fan-shaped caudal of Teleosts and other fishes. It is the final stage of the evolution of that fin.

Gephyrocercy and *gephyrocercal* are terms which will apply to the type of caudal structure appearing normally in only a few forms, such as *Mola* and *Fierasfer*. The end of the urosome in these forms, together with the posterior end of the chordal axis, is aborted. In consequence of this, the hinder epaxial and hypaxial tissues concerned in the formation of rays and their supports are approximated or swung round over the rayless interval existing over the stump of the axis, and by such a secondary process of growth the caudal fin-rays are formed, together with their interspinous supports. The interval between the vertical fins bridged in this way leads to the formation of gephyrocercal tail.

In the discussion of the neural and hæmal arches of the caudal vertebræ of heterocercal forms, it is also expedient to use some convenient terms which will indicate without circumlocution what is meant in speaking of the structure of these greatly modified elements. They will be spoken of as spineless if they are without dorsal or ventral spines, or as dorsally spineless, or as ventrally two or three spined, as in the case of the concrescent hypural bones, or as dipla- or triplacanthous.

The caudal part of the axial column may be perfectly *monospondylic*, that is, each of its vertebræ may have its dorsal and ventral spine, or every alternate vertebra may have these aborted, and thus become reduced to a centrum only, or become *diplospondylic* in the terminology of Von Jhering, or every alternate centrum may be said to be spineless.

The meanings of the terms *epural* and *hypural*, as applied to indicate the position of the caudal apophysial elements in reference to the cen-

tra, are used in the sense in which they were first used by Huxley in 1859 in his discussion of the development of the tail of *Gasterosteus*.

The word *opisthural* applies to apophysial elements in contact with the under side of the urostyle, but separated from the hypural pieces by an interspace, as in *Amiurus*.

The whole of the body of fishes from the vent backwards to the end of the tail will be frequently spoken of as the *urosome*. The exserted. or rather the degenerated, portion behind the urosome, as found in *Stylephorus*, *Chimæra monstrosa*, and the larva of *Lepidosteus*, will be called the *opisthure*, because it is behind the true or secondary caudal, which is developed after the former has begun to lose its function through the substitution of the latter. The word *opisthure* is by no means synonymous with *urostyle*, because it includes more, as in some of the cases mentioned above. It comprises the end of the chorda around which the osseous urostyle is developed; bands of muscalar tissue on either side, which are frequently rudimentary or imperfectly formed myotomes or muscular segments, beside connective tissue, the whole being covered externally by integument, which is continuous with that over the rest of the body.

In the case of a perfectly lophocercal form an imaginary horizontal plane cutting longitudinally through the center of the notochord will divide the urosome of a larval fish into an inferior and a superior half, and these halves may, roughly speaking, be said to be the dorsal and ventral counterparts of each other. All of the skeletal elements above the notochord may therefore be said to be *epaxial*, those below it *hypaxial* in position. This also applies to the median skeletogenous tract, the parts of which may be spoken of as epaxial and hypaxial in position.

The *skeletogenous tracts* of fish embryos seem to be largely intermuscular or intersegmental, perichordal, hypaxial, and epaxial, so that it is possible to trace the segmental development of the median and paired fins in early stages, and leads us to suspect that such a segmental arrangement may be effected from such *loci*, and thus determine the relations and serial arrangement of the rays and basal pieces of all of the fins. While the development of the rays and their proximal supports is often obscured by processes of coalescence, degeneration, and shifting, due to growth, future ontogenetic studies will unquestionably place the theory of all of the fins upon some such solid basis of observed fact. When the *skeletogenous tract* is spoken of here it is used with such implications.

The *embryonic skeleton* is at first mainly cartilaginous, and around or in this cartilage—usually the former—ossific deposits are laid down in a peculiar homogeneous kind of membrane which invests the cartilages (*Teleostei*). This sort of a *homogeneous membrane* may appear in the skeletogenous tracts of definite regions nearly as soon as cartilage, as in the case of the membranous rudiments of the shoulder girdle of Teleosts.

The development of the *rays* seems to begin peripherally in the fin-folds in membrane and approaches the *basilar interneural* elements from without, these latter being the most peripheral of the median series, which are developed in true cartilage from mesoblast. The rays are therefore sub-epiblastic, though their proximal ends may embrace nodules of cartilage of epaxial and hypaxial mesoblastic origin. The words *peripheral*, *distal*, and *proximal* will, therefore, be occasionally met with as used above.

The words *concrescence*, *coalescence*, are usually synonymous here as applied to describe the blending of series of bars of cartilage. The terms *homonym* and *homonomous*, *segmental*, and *metameric* are nearly synonymous in some cases. *Homonomous*, *homonomy*, *homodynamous*, and *homodynamy* are used in the sense defined in Gegenbaur's Elements of Comparative Anatomy. The term *serial homology* (Owen) is equivalent to the last of the above-mentioned words. *Metamerism* refers to the segmented condition of the vertebrate embryonic, and even, in fishes, to the adult axis, in which we find similar successive segments or *somites*. The word *urochord* is used a few times to designate the membranous part of the axis of the embryo when it is exserted beyond the hypural cartilages, to distinguish it from the ossified urostyle of the adult.

The term *protopterygian*, to designate the stage when the embryonic fin-rays first appear, was chosen to designate that condition when it may be said that true fins first appear. *Pterygoblasts* refers to the protoplasmic bodies from which the embryonic fin-rays are developed. The word *orthaxial* is used to designate the archaic straight type of vertebral axis, which is not bent upwards at its posterior extremity.

The word *actinost* as used by Gill applies only to the distal cartilaginous or bony elements of the limbs of fishes, which support the rays, or those more especially of Teleosts and Ganoids resembling them, and, inasmuch as these elements are clearly those from which their isomeral equivalents are evolved in the higher forms by concrescence, their homology throughout the *Lyrifera* becomes apparent, though very frequently fusion has occurred to form elements called the pro- meso- and metapterygium. Regarding the whole of the mobile axial skeleton of the limbs of the *Lyrifera* as essentially homologous, I will call the distal parts which directly support the true rays *actinophores*. While the Teleosts have had these elements much shortened as compared with the same parts as found in the Rays amongst Elasmobranchs, such a shortening is merely the result of extreme specialization growing out of adaptation. The basilar interneural and interhæmal nodules in this terminology become median epaxial or hypaxial *actinophores*.

II.—The theory of the development of the median fins.

The median fins of fishes normally present five well-marked conditions of structure, which correspond to as many stages of development, which in typical fishes succeed each other in the order of time. A sixth

exceptional form is developed in consequence of an extensive degeneration of the chordal axis and hinder end of the urosome, unaccompanied by the upbending of the axis, as in the case of heterocercy. The most archaic stages, or those found to appear during the younger phases of growth of fishes, are approximated by the structure of the fins of some of the most ancient Devonian, Triassic, and Jurassic forms, and by such living forms as *Chimæra*, the Dipnoans, Leptocardians, and Lampreys, but the parallelism of the development of the tail of young fishes with the successive modifications of caudal structure found in the forms of successive geological periods is not exact, as we shall presently show.

(1.) *Archicercy.*—The most primitive modification of the urosome is that which I will call *archicercal*, and which is characterized by the absence of any fin-fold whatsoever. While it is true that only a few degenerate or specialized forms of true fishes, such as *Hippocampus*, *Nerophis*, &c., permanently approximate such a condition, it must be admitted that the fins are acquired structures, and that the folds from which they are developed have been acquired in the course of the evolution of the ancestry of the fishes. The probability is that the history of the lateral fins is similar; that is to say, inasmuch as the paired fins of the lower types possess a greater number of rays (basalia) derived from the ends of the buds thrown off from the lateral somites than those of the higher forms, it would seem that the lateral folds which led to the differentiation of the pectoral and pelvic limbs were at first much longer than at present, possibly continuous with each other; such a conclusion would be favored by the presence of the large homodynamous series of cartilages which enter into the formation of these fins in Dipnoans and Elasmobranchs. The archicercal condition justifies such a conclusion, for during its persistence in normal forms there is little development of the rudiments of the paired fins; notwithstanding this, however, a noteworthy objection may be raised against this conclusion, which I have stated elsewhere.

When a young fish is developing in the egg its tail grows out at first as a blunt prolongation backwards of the body, which is for a time wholly without fin-folds, and is cylindrical and vermiform in general appearance, with the muscular somites clearly marked.

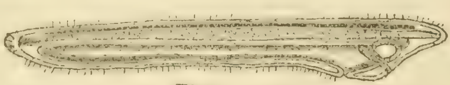


Fig. 1.

The larva of *Branchiostoma* (Fig. 1) is without median fin-folds, and that of *Petromyzon* seems to be without them during the very early stages, and, while we must make due allowance in both these cases for the effects of degeneration, we may, I think it probable, look upon these types as possessing at one stage a typically archicercal and vermiform tail. The solitary urochordate forms or Ascidians pass through an archicer-

cal stage of development of the urosome, according to the observations of Kowalevsky on *Phallusia mammillata*, and of Kupffer on *Ascidia mentula*. In the course of further development the Ascidians never seem to pass beyond what I have called the second or lophocercal stage, when the tail is absorbed in the caducichordate forms, but persists in the same stage in the perennichordate *Appendicularia*.

The Elasmobranchs seem to pass through an archicercal stage, while the Amphibians do not usually exhibit it in so pronounced a way, very soon becoming lophocercal, though the larva of *Dactylethra* has the anterior part of the urosome, with high median folds, while the termination is somewhat like that of *Chimæra monstrosa* (Fig. 2), but tapers more

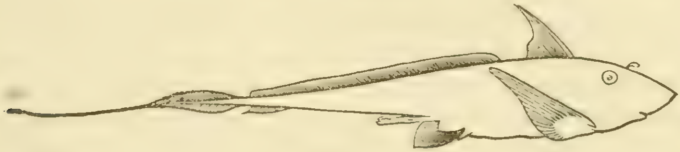
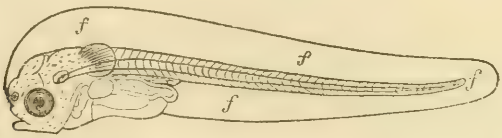


Fig. 2

and is typically archicercal. After the absorption of the lophocercal tail of an anurous amphibian larva has been in progress for some time, it seems to tend to lose its median folds somewhat and revert to the archicercal condition. This is also the case with the young of most *Urodela* as they approach maturity.

(2.) *Lophocercy.*—The second stage of development of the median fin system of *Ichthyopsida* is what I have called lophocercal (= protocercal, Wyman; = leptocardial, A. Agassiz) when it consists of continuous (Amphibia, Elasmobranchs, Teleosts, &c.) or exceptionally of discontinuous folds (*Siphostoma*, *Gambusia*), which do not include true permanent rays, but may at about the close of this phase contain the numerous fine embryonic rays of what may be called the protopterygian stage of development of the permanent fin-rays. The continuity of the median fin-fold in embryo fishes, as shown in Fig. 3 in the embryo cod,

Fig. 3.



seems to depend somewhat upon the extent to which the permanent fins are approximated so as to form a more or less completely continuous system in the adult. Several forms amongst the Clupeoids develop an expanded eradiate caudal fold, with the chordal axis dividing it into equal moieties, which thus anticipates the outwardly homocercal tail of

the adult. Beyond the lophocercal condition the typical fishes at once diverge from the rest of the *Chordata* and *Urochorda*, in that they develop groups of permanent rays in definite regions of the median fin-fold or continuously throughout its entire extent, and thus give rise to the distinct or continuous fins of the adult. The intervening parts of the fold in the first case atrophy, thus locally reverting to archicercy, the materials for the formation of the rays and their supports being supplied by the mesoblast which proliferates into the median fin-fold. The disposition of the materials for the development of the permanent rays of the unpaired fins seems to be under the control of heredity, which determines their permanent location or position in the primitive folds, which may be considered the matrix of the permanent fins.

In the formation of rays and their supports and musculature there is clearly a close correspondence between the number of ray-bearing somites of the body and the one, two, or three rays and supports which are developed to each segment, and this is manifested even when heterocercy and its accompanying degenerative processes manifest themselves in the caudal region of the most specialized forms. We find, in fact, that where apparent coalescence of two hypural elements has occurred, two corresponding mesoblastic thickenings of the caudal fold are developed, which extend from the lower end of the hypural pieces to the margin of the fold, and in and upon which the future permanent ray is molded. This segmental proliferation of mesoblast is possibly favored by the intersegmental disposition of the blood-vessels.

(3.) *Diphycercy.*—The most primitive disposition of the median fin-rays is a continuous one, as is indicated by the embryological evidence of the existence of a multiradiate protopterygian stage, and is hypaxial from in front of the vent in many cases, extending backward over the end of the tail thence epaxially and forward dorsally (*Cœlacanthi*, *Placodermi*, *Dipnoi*, Fig. 4). Another archaic trait which also marks a phase of the ontogeny of the Teleosts is the cœlacanthus (hollow) condition of the bony portion of the neural and hæmal spines and the interspinous elements. Fishes with a long, eel-like body have tended to remain diphycercal, while those whose bodies have been abbreviated have tended, with the exception of such forms as the Flounders, or *Heterosomata*, to develop discontinuous median fins, which have been derived from hypertrophied portions of a continuous series. This hypertrophy in some cases involved the whole series, e.g., *Platax*. The primaeval diphycercal condition is followed by the next stage, which grows out of the former in the course of further local degeneration and specialization, with a secondary upbending of the hinder end of the chorda. This view is fully substantiated by the development of the caudal skeleton of the eel, in which, in spite of its slight heterocercy, the diphycercal continuity of the fin series has remained prac-

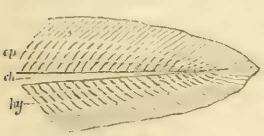


Fig. 4.

tically unimpaired, thus affording the necessary proof of the *serial homology* of the entire series of median fin-rays and their intermediary supports. Previous authors failing to attack this part of the problem by the light of the ontogeny of a diphycercal, eel-like type, have missed the solution of one of the most important minor parts of a rational theory of the median fins, since it is otherwise impossible to prove the existence of such a homology in forms with atrophied intervals between the vertical fins. The existence of the protopterygian stage also tends to prove this view to be correct. The skeletogenous tract, from which the whole of the median fin-rays and their supports are developed, is continuous in the median line of the urosome, above, below, and over the end of the chorda in fish embryos; such continuity affords an explanation of why the median fin-rays form an uninterrupted series in the case of perfectly diphycercal forms, or where the archaic has not yet been replaced by a specialized mode of development. Such an archaic condition is actually retained with but slight impairment by the embryo of the salmon, which has a nearly continuous series of embryonic fin-rays.

(4.) *Heterocercy.*—Heterocercy affects only the end of the chordal axis which is bent upwards (Fig. 5), as a result of which it and the later formed terminal vertebral segments are consolidated into a urostyle (in many *Teleostei*), above and below which epaxial and hypaxial elements are formed, of which the former are, however, often aborted and the latter widened as supports for the caudal system of rays. This condition appears to result from two causes, (1) great activity of growth in the terminal hypaxial part of the primitive fin-fold, in consequence of which the chorda is shoved upwards, and (2) by the actions of the animal in using the resulting expanded hypaxial caudal ray-bearing fold in swimming; the strokes of the fin in action, owing to the resistance offered by the water tend to throw up the somatic axis, just as an oar tends to be thrown upwards when used in sculling.

Fig. 5.

Since the hypaxial fold may be developed at some distance from the end of the tail, in the more specialized forms (*Lepidosteus*, *Gasterosteus*), a more or less free portion of the lophocercal caudal axis is left to project during the growth of the true caudal, as shown in Figs. 6 and

Fig 6.

Fig. 7

7. This part of the larval axis, which may be called the *opisthure*, subsequently degenerates, or it may persist as a prolongation of the

chordal axis, as in the diphycercal *Chimæra monstrosa*, or, as in heterocercal *Amiurus* (Fig. 8), it may, at an early stage, have the chorda exserted beyond the last hypural cartilages, and at some distance behind them have another hypaxial cartilage developed, which may be called opisthural, as it probably represents the remnant of proximal hypural pieces, which were developed in some more archaic ancestral form, in which diphycercy was more pronounced or even perfect. Where the caudal ray-bearing fin-fold is developed nearer the end of the chordal axis (*Apeltes*, *Siphostoma*, *Gambusia*) heterocercy is not so pronounced, as the urostyle is shorter, and only a part of the terminal vertebræ are involved, whereas in other cases (*Salmo*, *Lepidosteus*) more terminal vertebræ may be implicated by degeneration. In archaic forms of heterocercy there may be some epaxial rays and intermediary supports developed, while the hypaxial supports and rays extend to the end of the upwardly bent termination of the axial column. This trait may possibly differentiate the archaic type of heterocercy (*Palæoniscus*, *Platysomus*, *Acipenser*) from the more recent or specialized form (*Amiurus*) now prevalent amongst Teleosts, and which have for the most part a more or less well-developed urostyle, but with a very short or included opisthure (= dorsal lobe, Agassiz), and with epaxial spines of the urostyle displaced, rudimentary, or aborted. Outwardly homocercal Palæozoic fishes (*Dapedius*, *Pycnodus*) probably had an opisthural filament developed in their larval stages, which subsequently aborted, as in *Lepidosteus*, but in others (*Platysomus*, *Pygopterus*) the terminal part of the chordal axis doubtless became segmented, the segments bearing hypaxial caudal rays and few or no epaxial rays, so that the opisthure was probably rudimentary.

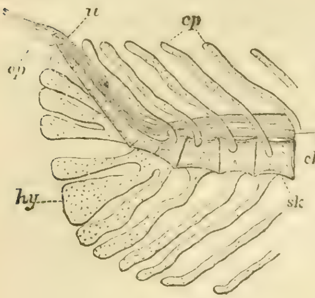


Fig. 8.

It thus becomes evident that the development of modern Teleosts presents only a partial or inexact parallelism with that of the Palæozoic *Rhomboganoidei*, for few, if any, of these forms show the urostyle so distinctly developed or the hypural pieces so extensively co-ossified as in existing Teleostei. The *Rhomboganoidei*, *Crossopterygia*, *Cycloganoidei*, and *Chondrostei* show a more decided tendency towards the development of a continuous dorsal and ventral or only ventral series of caudal rays, and thus trend more towards a diphycercal condition than the existing *Teleostei*, which may be said to be verging towards *hypocercy*, when all of the caudal rays will be of hypaxial origin, with frequently a rayless hiatus behind the last hypaxial pieces and the end of an exserted urostyle. These are some of the marks of progress which distinguish the Teleosts and supplement the significant fact of their well-ossified skel-

eton. It is probable that we have no remains of the larvæ of Palæozoic fishes preserved in the rocks, so that we have no means of contrasting their early phases with those of existing forms, but it is certain that none of the most simple forms of the Palæozoic fishes, in respect to their skeletal structure, even approximate such a primary condition as the lophocercal stage. Of modern forms, the only trait which they possess in common are continuous median fins, in the first, containing permanent rays, the latter without them, but at most provided with embryonic fin rays only. When we know the larvæ of *Ceratodus*, *Polypterus*, *Lepidosiren*, and *Protopterus* as well as we know that of *Lepidosteus* we may have a more comprehensive understanding of the main features of the larvæ of Palæozoic fishes.

The evidence in favor of degeneration of the caudal region is the existence of a permanent archicercal opisthure in *Chimæra monstrosa* and *Stylephorus chordatus;* the extensive development of a temporary opisthure in *Lepidosteus;* the concrescence of the hypural pieces; the ventrally diplacanthous and even triplacanthous caudal vertebræ or their coalesced representative, the urostyle; the existence of hypaxial opisthural elements; the abortion of the epaxial spines of the caudal vertebræ, and finally the abortion or extreme modification of the last muscular somites of the caudal region.

(5.) *Homocercy.*—This merely expresses the condition of epaxial and hypaxial symmetry presented by the fan-shaped caudal of Teleosts, and is the final term in the evolution of the growth of the rays of that fin, in consequence of which the archaic symmetry of perfect diphycercy becomes again restored though the structure of the tail is heterocercal.

(6.) *Gephyrocercy.*—This type of tail appears to be normally met with in only two forms, of Teleosts, namely, *Mola* and *Fierasfer.* The primitive opisthure or end of the urosome in these forms is apparently aborted in the first case, in the course of larval existence; in the other, during post-larval life. As a result of this a hiatus is left between the epaxial and hypaxial rudiments of the median fins, and in the center of this hiatus the axial column ends abruptly as if cut or bitten off. The hinder hypaxial and epaxial tissues concerned in the formation of rays and their supports are then approximated and developed later than the other median fin-rays, and the interval so bridged by a secondary process of development leads to the formation of what we may call a gephyrocercal* tail.

III.—On the degeneration of the posterior part of the axial skeleton of fishes.

There is undoubted evidence of the extensive degeneration and consequent modification of the caudal part of the vertebral axis of fishes. This is apparent upon making a study of the tail of the entire series of

* γέφυρα, bridge; and κέρκος, tail.)

Teleosts and one of the *Holocephali*. The complete absorption of the tail of the larval *Anura* is also interesting in this connection, and, as already suggested by Huxley, may account for the development of the styliform, unsegmented urostyle which terminates the vertebral column in adult *Anura*, as an ossification of the proximal part of the chordal axis of the tail of larva.

It may be that the intestine terminated much farther posteriorly in the most primitive forms of the *Vertebrata*, when they were more worm-like, with a terminal anus. With the degeneration of the body-cavity, and its specialization anteriorly, the caudal region probably became rudimentary, and was either partially absorbed, or became specialized into a portion of the body the sole office of which was to aid in locomotion. With this acquisition of a new function the degenerating tail has passed through a remarkable series of changes, which left the posterior axial elements to atrophy more or less, while their hinder appendages, which were more or less well preserved, became intermediary supports for appendicular rudder-like organs or a fin-skeleton developed in the skin. *Polypterus** shows how far back and near the tail the body-cavity may extend. As extremes of the opposite kind may be cited the entire group of the *Heterosomata* and the case of *Orthagoriscus*, fully discussed in another place. This last-named case of extreme reduction or degeneration surpasses even the specialized condition found to obtain in the tail of *Hippocampus*.

In *Gastrostomus* we meet with a condition of the vertebral column resembling its condition in the allied form *Eurypharynx*, writing of which it has been said by Vaillant that its body seemed in its progress to the tail to lose its bones and be converted into a sort of tough and gristly appendage. While such a statement is hardly true of *Gastrostomus*, the caudal portion of the axial skeleton is exceedingly degenerate, the vertebral segments long but without distinct upper and lower arches, and so little ossified as to consist of very little else than the membranous notochord, which actually does appear to constitute the extreme terminal part of the axis of the body. This condition therefore recalls the structure of the tail of *Chimæra monstrosa*, with its caudal axis prolonged as a filament, or that of the singular type called *Stylephorus* by Shaw.† The caudal filament of *Stylephorus* is, however, twice the length of the body, or 22 inches. The "caudal" fin consists of five epaxial spines, if Shaw's figure is trustworthy. The form therefore has no true hypaxial caudal rays, as in nearly all Teleosts; in fact

* *Polypterus* also has the ribs passing outward through the lateral muscles to the skin anteriorly, somewhat as in the sharks, while they girth the body-cavity posteriorly, as in other fishes. The character which Balfour insisted upon as one which distinguished the sharks from Ganoids and Teleosts, therefore, has no great taxonomic value, unless this trait of *Polypterus* should be found to be characteristic of all of the Crossopterygians and not be found in any other fishes.

† Shaw's Naturalists' Miscellany, VII, Pl. 274.

Shaw's figure shows that there are absolutely no hypaxial rays developed, nor does the accompanying description mention them. The form therefore contrasts morphologically with *Gymnotus*, which has no dorsal or epaxial system of fin-rays.

Dohrn* has lately published some interesting and important speculations upon the phylogenetic origin of the paired and unpaired fins. He lays particular stress upon the presence of a postanal gut in fish embryos as determining the abortion of the preanal unpaired median fin-fold, and its division into two ventro-lateral folds, which he thinks it conceivable were derived from the parapodia of a worm-like ancestor. The abortion of the postanal section of the gut in vertebrate embryos has permitted the approximation or coalescence medially of these primitive lateral folds or metameric series of papillæ from which parapodia have been evolved in worms, and which led to the differentiation of paired fins in their vertebrate offshoots. Since Dohrn's investigations have undoubtedly shown the archipterygium and cheiropterygium hypotheses of Gegenbaur and Huxley to be utterly untenable, as had been pointed out before by Balfour, there are still some difficulties in the way of Dohrn's own conclusions, which seem to me to be serious enough to be worthy of passing notice. What is here referred to is the presence of preanal unpaired fin-folds in certain forms of fish embryos, as in *Alosa*, *Pomolobus*, *Salmo*, *Coregonus*, *Cybium*, *Lepidosteus*, &c.,† and which would indicate that the presence of the intestine in these instances had not exerted the influence which he has suggested. In *Alosa*, *Pomolobus*, and *Lepidosteus*, this preanal fold, contrary to what is found in Elasmobranchs, is especially well developed. It is therefore evident that Dohrn's view of the origin of the median folds does not hold for all of the *Ichthyopsida* without some modifications.

Dohrn is right, however, in the view that what I have called the urosome is a structure secondarily developed, for, as he points out, we know from the researches of Goette on *Bombinator*, Kowalewsky and Hatschek on *Amphioxus*, and Balfour on the Elasmobranchs, that there exists an open communication between the primitive neural tube and the intestine by way of a *neurenteric canal* and *postanal gut*, and that while such a relation is obscured somewhat in Marsipobranch and Teleostean embryos, traces of it nevertheless exist even in those types. The tendency to develop an anal opening considerably anterior to the end of the tail after the archicercal or worm-like condition is passed over, while the postanal section of the gut atrophies instead of developing a quite terminal anus after the manner of many worms, is very significant, and would indicate that we have here an instance of degeneration manifesting itself at a very early period. This process of degeneration by which in reality an advance is made upon the more prim-

* Studien zur Urgeschichte des Wirbelthierkörpers, Pt. VI. Mitth. zool. Sta. zu Neapel. V. Hft. I, 1884, pp. 174–189.

† A contribution to the Embryography of Osseous Fishes, § 18, p. 67.

itive worm-like plan recapitulated by embryonic development, leads to the differentiation of the anterior or cephalic and somatic parts of the form from the caudal part. Such a differentiation really leads to the production of a number of very important morphological and physiological changes, but it also at the same time affords embryological evidence of the fact that the theory of serial homologies founded on the tail of the eel is correct.

The degeneration—possibly specialization—which we have observed to occur in the course of the development of the tail of embryos is followed by other degenerative processes of considerable significance. The most important of these are, of course, those which lead to the evolution of heterocercy and the formation of a urostyle, but the instances in which we observe degeneracy to be so palpable that we cannot deny the fact of its existence are apparently those of *Chimæra monstrosa*, *Gastrostomus Bairdii*, and *Stylephorus chordatus*, in which a long *opisthure* has been formed, which at a very early period was vermiform and practically without developed median fin-folds. This almost useless *opisthure* results from the failure of the animals under consideration to develop in this region, during their early stages, well-marked myotomes, or if they ever did develop they subsequently degenerated more or less completely, leaving little or nothing behind except the chorda invested by connective tissue and integument.

If, as it is possible to conceive, the original form of the vertebrate body had more segments than it now has in even such comparatively simple forms as heterocercal Teleosts, it is not unreasonable to suppose that the failure to fully develop the terminal myotomes actually helped to lead to the initiation of heterocercy, for the reason that not sufficient material was built up into muscular segments at the tip of the tail to supply the muscular bundles for the formation of the flexors and divaricators of the caudal rays of heterocercal forms, the musculature of which has been really derived by differentiation of certain antepenultimate myogenous segments. This failure of the myogenous tract to develop in the last segments may have resulted partially from the sufficiency of the more anterior part of the urosome for purposes of propulsion in a watery medium, so that its posterior part failed to become functional from disuse, and was from such a cause atrophied, owing to a diminishing blood-supply which must have supervened.

I am also aware that the number of myotomes found in Teleost embryos before the body becomes free anteriorly and posteriorly from the yelk varies in different families, so that the preceding argument must be qualified by just so much as such variations in the number of larval somites developed may be supposed to affect the number in the adults of different groups. This larval variation actually depends upon the number of segments functionally developed in the adult, as is shown by the development of *Belone* (*Tylosurus*), by *Fierasfer*, and the Leptocephalid stages of certain marine eels, when contrasted with the young

stages of the higher Teleostean forms possessing a shorter somatic and caudal region with fewer somites and a much modified heterocercal tail.*

Such forms as *Stylephorus*, *Chimæra*, *Gastrostomus*, and *Eurypharynx* would throw a great deal of light upon this subject, if we knew their embryonic history as well as we know that of *Fierasfer* and *Echiodon* so ably worked out by Carlo Emery.† The morphological and embryological evidence of caudal degeneration in *F. acus* is most complete, for the chorda with a blunt rounded posterior end (Fig. 4, Plate VII) abuts directly against the integument which covers the end of the tail. In *F. acus* the terminal caudal vertebræ are most imperfectly developed, while in *Echiodon dentatus* (Fig. 3, Plate VII) there is a more complete development of the last vertebral body, that vertebra manifestly not being the last one which would have been developed had the chorda persisted. In the first form there are no interneural cartilages developed as in the latter; these facts, therefore, taken together with the more pronounced persistence of the chorda in *F. acus*, show that the latter has retained a more embryonic condition of the tail than *E. dentatus*. *E. dentatus* is typically gephyrocercal, while *F. acus* has not developed the tail so completely as even to attain the condition of gephyrocercy, so that *it is absolutely without a true caudal fin.* On these and other grounds, Dr. Gill thinks it proper to distinguish these forms as separate genera. The young of *E. dentatus* has a very long and flagelliform tail which seems to be more prolonged than that of *F. acus* in the relatively younger "*Vexillifer*" stage, and which is either absorbed or even possibly lost in some other way, but it does not matter from what cause the tail is lost, the fact remains that in *Echiodon* the caudal, or what represents that fin in other fishes, is formed by the coalescence of a short posterior section of the dorsal and ventral series of rays into a terminal fin having the same function as that found in heterocercal types.

If both the heterocercal and homocercal types of the tail show in a great number of instances that the caudal extremity has been at one time provided with a more or less well-developed opisthure, and if such an opisthure does not in some cases even bear a fin-fold, but is merely the terminal part of the original urosome of the larva, it would seem that such forms had descended from types at one time possessed of longer tails with well-developed myotomes extending to their very ends, and that they were at first lophocercal, as are the larvæ of existing fishes. The enfeebled or degenerated posterior part of the urosome, which we designate as the opisthure, may not have contained sufficient muscular tissue to flex it from side to side, and that condition may have been brought about during development. In fact, less meso-

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* See my paper on the Development of the Silver Gar (*Belone longirostris*), Bull. U. S. Fish Commission, I, 1881, p. 293, Fig. 11, Pl. XX.

† Atti R. Accad. dei Lincei, VII, 1879–'80. Fierasfer. Studi intorno alla sistematica, l'anatomia e la biologia delle specie mediterranee di questo genere pel dott. C. Emery.

blastic blastema may have been laid down in the primitive terminal somites, so that the urosome was slender and weak from the embryonic period onward. This might readily lead to the degeneration of the caudal fin-fold, for the reason that no surplus of mesoblast was previously laid down in the vicinity which could be proliferated into the terminal fin-folds, consequently no caudal rays, apophyses, or even fin-folds were developed. Degeneration would then assert itself in the higher forms by the development of a transient opisthure; in the lower forms either a persistent opisthure would be formed, or the whole tail would become slender, weak, and flagelliform, as in the Rays and in *Gastrostomus*.

With the loss of mobility, or rather of muscular power, owing to a lack of well-defined muscular segments, it would result that no vertebral segments or only very imperfectly differentiated vertebræ would be formed, such as we actually find to be the case in *Gastrostomus*. Converse reasoning from another set of facts leads to a similar conclusion. In every case where a well-marked urostyle is developed from the point of axial flexure it is unsegmented when fully formed, as in *Amiurus*, or it is unsegmented at its posterior extremity only. The degenerate posterior extremity of the chorda often becomes covered by a continuous osseous investment which renders it inflexible, a condition which could not have been established if the musculature on either side had been well enough developed, and the end of the urosome had retained its archaic or straight form. When, however, heterocercy was developed the musculature of the tail became subordinated to a new function, viz, flexing the powerful caudal rays upon the hypural bones; the forces competent to induce segmentation of the urostyle are therefore absent, as it is usually found that the segmentation of hard parts corresponds pretty closely in the lower forms to the points of segmentation or to the points of origin and insertion of the muscles. With the advance in the differentiation of the muscles, as in the limbs of mammalia for example, this correspondence is less marked, being obscured by secondary adaptation.

The evidence in favor of the doctrine that many of the recent Teleosts, as well as the recent and fossil Ganoids, have descended from an ancestry the urosome of which was more prolonged or contained more segments than the urosome of existing species, is therefore quite conclusive, and that what has led to this decrease has been the further functional specialization of the caudal fin. In fact, a survey of the Vertebrates, taken as a class, leads to the conclusion that in almost all orders there has been a tendency in the course of their phyletic histories towards a degeneration of the caudal part of the axial skeleton.

The remarkably uniform tendency of nearly all of the *Lyrifera* to become heterocercal, involving the degeneration of certain parts which enter into the tail, would indicate that similar causes were operative amongst such a diversity of forms, productive of such similar morpho-

logical effects. The interaction between the Lyriferous type and its environment must have been pretty uniform in its character, because that environment—water—has been constantly about the same as respects its density, penetrability, and the resistance it would offer to the movements of the fish-like organisms immersed in it, so that in form and organization these latter have within certain limits remained pretty constant in their general conformation, widely as they differ in morphological details. Such a uniformity of tendencies shows that the forces competent to effect their initiation have not been haphazard, or fortuitous, or dependent upon chance variations to favor their operation, but have been fixed by determinately acting energies, the effects of which the writer has sought to trace. The embryologists have afforded us the clew to the origin of vertebrate bilaterality from structures which have been functional in the lowest Metazoa, and if this bilaterality so inherited has the significance which it appears to possess in determining further modifications, such as the differentiation of the vertebrate skeleton and metamerism in general, we are probably not far from a possible solution of most of the problems which confront us in the simple organization of the fishes, which foreshadows the far more complicated organizations of the higher types.

We have seen that the weak, lophocercal tails of young fishes frequently did not contain the materials for the complete differentiation of the axial and median distal appendicular parts of the skeleton. Then, as the upper and lower lobes of the caudal fin are developed, the tendency to develop the second anal or "lower lobe" of authors to a greater extent than the upper, there has been a tendency to push the tip of the chorda upward, or to push its ventral parietes inward (*Alosa*) for some distance in front of its hinder end. This hinder extremity then degenerates, or extensive anchylosis of the imperfect caudal segments of the axis and their appendicular elements supervenes, which aids in carrying the degeneracy of the chorda still farther at this point. The principle is the same, as we find upon careful analysis, which obtains in both the most primitive types of fishes and in the early stages of development whereby the rays become located and developed anteriorly to the end of the chorda, so that what has followed is mainly the result of the acceleration in the development of the lower or ventral part of the median fin-fold, from which what is morphologically a second anal is formed, in a position in which there is no corresponding dorsal lobe developed as its dorsal antitype, in consequence of which there is a lack of balance on either side of the end of the chorda in respect to the mode in which work is done by the tail, especially by the ventral lobe, which then becomes a kind of oar or sculling organ. In action this ventral lobe, when moved from side to side, encounters resistance from the water, and as it is alternately flexed in an oblique direction to the line of greatest resistance, the resultant of the antagonistic forces will pass obliquely upwards and across the axis of the tail; this obliquity of action of the

resultant forces being alternately reversed as often as the tail is vibrated in opposite directions, will tend to throw up the end of the axis of the body, and thus produce a heterocercal condition, or one in which the end of the notochord will at least tend to be bent upwards. In case the dorsal and ventral rays of the tail are equally developed, there is no disturbance or upward displacement of the notochord, as may be seen in the cases of *Chimæra*, *Protopterus*, and *Ceratodus*, because here the interacting forces, if their lines of action are traced, may be shown to have a tendency to promote a preservation of the original or lophocercal symmetry, in which the chordal axis is straight posteriorly.

The extent of the development of the ventral lobe is highly variable, but it usually presents the greatest amount of surface laterally if the line of curvature of the urostyle, which is the true caudal axis, be used as the line dividing the ventral and dorsal lobes, and the curvature of this line is the index of the degree of heterocercality. It follows from this principle also that there is a correspondence between the proportion of the dorsal and ventral lobes to each other, and the degree to which the extremity of the chorda or axial skeleton is bent upwards posteriorly, if the principle of mechanical evolution here traced has any meaning.

An examination of a large series of types beginning with the *Chondrostei*, *Selachii*, *Crossopterygii*, *Rhomboganoidei*, *Cycloganoidei*, and ending with the most highly differentiated members of that series, the Teleosts, shows that the second anal or lower lobe of the caudal is not serially in the same relative position in different types; that in some forms it arises near the end of the axis of the embryo, in others a long distance in front of the termination of the axis of the body. Upon the location of the lower lobe, therefore, depends the number of segments in the dorsal or axial lobe of the tail from the point where it is flexed upwards to its termination. In *Alopias* there are about two hundred segments in the long dorsal lobe of the tail, and in some Teleosts there may be no vertebræ at all developed behind the point of upward flexure, as in *Gasterosteus*, for example, where the axis of the dorsal lobe is represented only by the urostyle and modified posterior half of the last vertebræ. The range of modifications which the tails of fishes undergo is, therefore, largely conditioned by this variation in the position of the ventral lobe, which may be placed near the end of the axis or far in front of it, and thus involve a smaller or larger number of the terminal segments of the axis in the upward flexure of its terminus.

The point of flexure of the chordal axis ought, if the mechanical hypothesis here outlined is at all probable, to begin at the anterior margin of the lower lobe, which is what we find to be the case. From the type in which the caudal axial skeleton is not flexed, as in *Ceratodus*, to the extremest type known, namely, *Alopias*, this rule holds. The cases of *Anguilla* and *Cnidoglanis* are somewhat difficult to reconcile, yet in truth their heterocercy is but slight, the caudal being reduced to eight

dichotomous rays in *Anguilla*, Fig. 4, Pl. 4, and it would seem that the apodal condition and the elongate body had reacted so as to prevent the development of heterocercy, or it may be that this form has descended from a type which began to be heterocercal, but which lost that condition to some extent in the course of becoming apodal, when the tendency to preserve the tail in its primitive form began to assert itself and prevented further caudal degeneration, and that loss of terminal segments which we have seen has occurred to some extent in the course of the evolution of the fishes.

Kolliker,* as a result of his investigations, proposes the following provisional scheme of classification for the structural conditions found to obtain at the hinder end of the axial columns of fishes:

A. The end of the vertebral column incompletely or entirely unossified.
  I. The end of the vertebral column without a spinal canal, but consists—
    1. Of the chorda alone, *Esox*.
    2. Of the chorda principally, which is, however, covered by a short more or less complete cartilaginous sheath, *Salmo*, *Alosa*, *Elops*.
    3. Of a complete cartilaginous tube which incloses the end of the chorda, *Cyprinus*.
  II. The end of the vertebral column consists of a cartilaginous sheath, which incloses both the ends of the chorda and the spinal cord, *Polypterus*, *Lepidosteus*, *Amia*.

B. The end of the vertebral column completely ossified.
  I. The end of the column is not segmented, but consists of a longer or shorter bent bone (*urostyle*, Huxley), which is to be regarded as an ossification enveloping the chorda, and which resembles, more or less, anteriorly, a vertebral body. All (?) *Acanthopteri*, *Malacopteri* in part.
  II. The vertebral column ends with a simple vertebral body, *Plagiostomi* with a fully ossified vertebral axis.

These histological and morphological results of Kölliker's researches are of great interest, but they throw but little light upon the questions which we are attempting to elucidate on the basis of embryological and mechanical hypotheses, until they are viewed through the medium of the latter. The facts given in the table above merely show, as all of our studies have shown, that all the types of caudal differentiation found in fishes are stages tending toward the concentration of the caudal skeleton towards a point in advance of the hinder end of the chorda. The differences observed in the details of structure at the posterior end of the chorda are such as merely indicate phases of specialization. This is quite clearly demonstrated by the fact that a series of conditions might be picked out from this table which would roughly correspond with a series of the stages of development of a young fish.

IV.—THE SERIAL HOMOLOGY OF THE HYPAXIAL AND EPAXIAL ELEMENTS OF THE CAUDAL FIN.

Huxley has held that the hypural pieces of *Gasterosteus* were in reality composed of hæmal and interhæmal pieces, as indicated by develop-

* Ueber das Ende der Wirbelsäule der Ganoiden und einiger Telostier. 4to. Leipzig, 1860.

ment.* An investigation of the structure of the caudal fin of *Anguilla*, Fig. 4, Pl. IV, very young individuals being used for the purpose, shows that this view of the structure of the tail of fishes is probably the true one, for reasons which we will now present.

In the first place, the Eel seemed to us to be especially well suited to clear up any doubts upon this question, for the reason that, if there was any actual serial homology to be found throughout the extent of the unpaired fins, such a condition ought to be apparent in this type, in which the dorsal, anal, and caudal are serially confluent, and the mode of transition from the one to the other ought consequently to be apparent. This, I am glad to say, was found to be the case, as had been anticipated on morphological grounds.

An exact drawing of the relation of the last interspinous pieces of the dorsal and anal fins shows that these pieces are not confluent with the neural and hæmal spines, but the first true hypural process is sharply bent backward at a point which is serially on the same level with the break in the continuity between the hæmal arches and every alternate interhæmal piece of the anal in front of it, as seen in Fig. 4, Pl. IV. A slight flexure of the same kind is visible in the next hypural piece. From this circumstance I infer that the hypural pieces are not simply hæmal, as held by Balfour, but are, as held by Huxley, composed of at least both hæmal and interhæmal elements, and that the point where the abrupt flexure of the first hypural piece is found marks the point where there was formerly a separation between the hæmal spines and the interhæmal pieces. That the distal parts of the hypural pieces of the heterocercal part of the tail of the Eel are not hæmal is proved by their exact serial relation to the interspinous pieces pertaining to the anal in front of them, the hæmal arches being abbreviated so as not to extend as far out or so near to the margin of the muscular mass, dorsally and ventrally, as does the terminal portion of the hypural pieces. The complete separation of the interspinous cartilages from the hæmal arches shows that the former cannot be medially fused pleurapophyses, but must be hæmapophyses and interspinous elements together. Moreover, at no time can it be shown that the distal parts of these hypural pieces in the Eel arise from the fusion in the middle line of distinct cartilaginous rudiments homologous with ribs, any more than it could be demonstrated that the interspinous pieces were so formed. Of other young fishes and embryos the same may be said; yet I admit that, if the truth of the theory of caudal degeneration and specialization which I have sought to establish is well founded, it may be that the lateral halves of the median, proximal, neural, and hæmal elements fail to develop, for the reason that the process of degeneration has affected their primitive mode of formation. Yet even this, for evident reasons, would not necessarily vitiate the conclusions

* Quar. Journ. Mic. Sci., 1859.

arrived at respecting the serial homology of the epural and hypural bones in the tails of *Holocephali*, Ganoids, and Teleosts.

An examination of the tail of the Eel has, as already stated, led to the belief that a part of the hypural bones are the homologues of interspinous bones; but we find that even in this case they are present as a pair of successive appendages on the inner side of the ultimate and penultimate vertebræ. The next step in our inquiry will therefore be the following: What is the probable cause of such a duplication or multiplication of median appendicular elements on the under side of the posterior end of the vertebral axis? The antepenultimate vertebra, which has nothing to do with supporting the caudal lobe, has a single neural arch and two hæmal arches, and to these correspond two inferior interspinous elements. This would seem, therefore, to indicate that the double hypural elements of the penultimate and ultimate vertebræ were in part, or at least distally, the homologues of interspinous elements.

The neural arches of the penultimate and ultimate vertebræ are wanting, and there are no superior interspinous pieces which belong to the two last vertebral segments. This implies a degeneration and complete atrophy of the dorsal interspinous pieces pertaining to the caudal vertebræ, while it is evident, from what has been said above, that the inferior homologues of the suppressed upper pieces are present.

The inferior elements, or true hypurals, of the Eel are present as four hypaxial apophyses formed in cartilage and ensheathed in membrane bone in the young animal. In the old animal these four elements are reduced to two, because of the fact that the sheaths of membrane bone investing the two successive two in the young become co-ossified.

Further possible conclusions are derivable from a study of the structure of the tail of the Eel. The penultimate vertebra bears two inferior arches, which are hæmal, but it supports only one neural arch. This may imply that at one time this vertebra was compound, or double, and that it is now fused into one, having lost one of its neural arches. Such a duplication of centra occurs in the caudal part of the axial column of *Amia*, but here the appendages of the alternate segments are suppressed.

The concrescence or crowding together and fusion of the proximal ends of the epural and hypural elements, so frequently noticed, seems, however, to be really due to the tendency of the heterocercal caudal structure to incline toward the development of that of the gephyrocercal condition, as pointed out in another place.

The diplospondylism of part of the caudal axis of *Amia* is not apparently due to a process of concrescence, but to the elision of some of the skeletal appendicular parts of alternate segments. At the other extreme the excessive multiplication of epaxial arches to a single segment in *Lophobranchii* is an instance of the acquirement of supernumerary arches, which it is difficult to account for unless it be supposed that the single myotomes of the adults of the existing forms represent

several primitive myotomes fused together, the septa between the latter having supplied the materials for the arches in excess of those demanded by the number of existing myotomes. But investigation again shows that such a view is not tenable, because the number of myotomes in the larva of *Siphostoma* are not in excess of those in the adult, so as to justify the hypothesis just outlined; so that it is evident, in this case at least, that the number of homonomous appendages of a segment may form a series which may be a multiple of the homonomous segment. Such results throw considerable doubt upon the legitimacy of the inference that the primitive cartilaginous rays of the paired fins of Elasmobranchs are each homonomous with a single segment.

The hypural pieces are really composed in many if not in most heterocercal forms of several median appendicular pieces fused together, and are usually not a little expanded at their distal ends, so that one of these processes frequently gives a basis of support to a number of caudal rays. In *Gasterosteus* and *Scomber*, for example, the fusion and expansion of the hypural pieces have proceeded so far that they are present merely as two fan-shaped pieces in the former, while in the latter the last vertebra is expanded posteriorly so as to present but one process which can be considered as the homologue of the series of hypural bones of other forms. In still other forms, such as *Lophius*, the process of specialization of the caudal end of the axial column proceeds so far as to involve vertebral segments in advance of those supporting the caudal rays. In this way it results that a number (about three) of the caudal vertebræ in this genus become fused together by synostosis.

There is a tendency in heterocercal forms for the neural arches to become more or less suppressed or aborted, apparently for the reason that the upturning of the posterior end of the chorda, when heterocercy is in process of development, encroaches upon the position which the posterior neural or epural arches originally occupied in the unmodified diphycercal type of tail. This pushing upward of the end of the chorda within the caudal fold seems therefore to really occur, and to play an important part in the evolution of the specialized caudal of Teleosts. In the Eel there are three hypural processes, which have no epural homonyms. Even when the epural pieces are developed as far as the cartilaginous condition, as the serial homologues of those in advance of them, they often have their direct connection with the chorda or urochord more or less sundered, owing to the degenerative influence of the upbending of the end of the latter, as may be seen in the course of the development of many forms. Sometimes the epural arches, or antitypes of the hypurals, are completely suppressed, as in *Amiurus*.

The tendency toward suppression of the epural pieces and that of the hypural pieces to become distally widened are correlative, and are evidently to be ascribed to the same causes. While the epural elements are being suppressed by the upturning urochord, the development of their cartilaginous beginnings even being interfered with, the hypural

elements have been given more room for development in an antero-posterior direction distally. In consequence of this they have been frequently much widened at the distal extremities. This expansion of the hypural cartilages has then influenced the subsequent development of the membrane in which ossification occurs and also extended or expanded its development.

In *Amiurus* there is a small somewhat bent cartilaginous nodule found just at the apex of the urostyle, Fig. 1, Pl. IV, *op*, or at the extreme tip of the chorda in a still younger stage. This nodule is evidently an almost suppressed member of the once more extended series of hæmal arches. It is separated by a considerable interval from the last hypural piece in the young fifteen days old, and belongs to a system of arches which were doubtless well developed farther back in time in the ancestry of this form.

The position of this nodule in relation to the hypural pieces and to the end of the chorda and the extremity of the spinal cord, which here extends backward beyond the end of the notochord, would seem to prove that there probably was a time during the phyletic history of the Catfishes when the tail was longer and more nearly approached the most primitive diphycercal condition. The extension backward of the spinal cord beyond the end of the urostyle is also strong evidence in favor of the probability of the existence of a diphycercal condition which preceded the present one.

The sigmoid flexure of the end of the spinal cord *ms*, in Fig. 1, Pl. IV, is also evidence in favor of the theory of the upbending of the chorda which was defended above. The suprachordal portion, over the urostyle, has been bent up, but the part extending behind the end of the urostyle has not been bent upward at the same angle, but is very much less inclined to the plane of the axis of the body than the portion immediately in front of it. So it appears that the upturning of the chorda seems to affect the upbending of the spinal cord to the same extent as itself only as far as the two structures coincide in their relative positions of parallelism with each other.

The exserted end of the spinal cord in *Amiurus* rests ventrally upon the opisthural piece *op*; it, like the end of the cord, has not been so extensively pushed upward distally as the more anterior, ultimate, hypural piece, the axis of which has been shifted through at least ninety degrees from the position it occupied in the old diphycercal type in which it first appeared.

V.—Development of the Median and Paired Fins and the Effects of Concrescence.

The structure of the tail and of the median fins of fishes has been described by a number of eminent authorities, but it is only within a few years that we have been furnished with the kind of embryological knowledge which has enabled investigators to reach any general and

harmonious conclusions regarding this subject. The researches of A. Agassiz* upon the mode in which the tail of the most highly specialized fishes is developed are the most important and extensive, but it is to be regretted that his illustrations do not give the outlines and relations of the hypural chondrifications in greater detail for all of the species which he has considered, his object being apparently to identify the forms and trace their metamorphoses without entering too much into elaborate minor details.

For the relations of the embryological structures involved we are still mostly dependent upon the researches of Balfour, Oellacher, Lotz, Swirski, Dohrn, and myself.

Since Balfour's discovery that the paired fins are apparently developed, at least in the Elasmobranchs, from continuous lateral folds of the epiblast into which the mesoblast proliferated to form the vascular, axial, radial, and muscular systems of the limbs, there has been a large amount of evidence gathered which shows that the history of the paired and unpaired fins of Teleosts is very similar. Oellacher† was the first to trace the origin of the axial substance of the pectoral limbs of the Trout to the mesoblast. Since Oellacher's observations have been published, Dohrn‡ has reconsidered the development of the paired and unpaired fins ontogenetically, and has fully confirmed and greatly extended Balfour's original conclusions, so that we now have a secure foundation upon which to found a theory of the fins which does not rest upon hypothetical assumptions, but upon observed facts.

Dohrn holds essentially the following views respecting the origin of the paired fins, viz: (1) As shown by Balfour, they are derived from continuous, inferior, horizontal, lateral folds of epiblast, into which muscular and other mesoblast proliferates. (2) The muscular somites then throw out ventral buds which are thrust into the fold, in segmental order, when they become constricted off from the somites, *mb*, Fig. 9, Pl. X. (3) These segmental muscular diverticula then divide into dorsal and ventral processes, which give rise respectively to the inferior and superior muscles of the actinosts and rays. (4) The *actinophores* are then formed by a gradual chondrification of the loose mesoblastic tissue between the divided diverticula of the muscular segments. (5) As the paired fins become longer and more pedunculate, the primitive actino-

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* The development of Lepidosteus. Part I. Proc. Am. Acad. Arts and Sci., XIII. 1878, 65–76, 5 pls.

On the young stages of Osseous Fishes. I. Development of the tail, Proc. Am. Acad. Arts and Sci., XIII, 1877, 117–127, 2 pls. II. On the development of the Flounders, Proc. Am. Acad. Arts and Sci., XIV, 1878, 1–25, 8 pls. III. On the young stages of Osseous Fishes, Proc. Am. Acad. Arts and Sciences, XVII, 1882, 271–303, 20 pls.

† Beiträge zur Entwickelungsgeschichte der Bachforelle. Vorläufige Mittheilung. Ber. d. nat.-med. Ver., Innsbruck, 1879, pp. 141–143.

‡ Mitth. zool. Sta. Neapel, 1884. V. Die paarigen und unpaarigen Flossen der Selachier, pp. 161–189.

phores, which correspond to the segments whence the muscles are derived, coalesce at their proximal ends to form the basipterygial cartilaginous plate, Fig. 8, Pl. X, which subsequently segments to form the pro- meso- and metapterygium. The antero-posterior constriction of the horizontal peduncles of the pectoral and pelvic fins is greatest from behind, so that a fold of skin is pushed in behind the basipterygial plate, shoving it outwards and freeing it posteriorly from the sides of the body to thus give rise to the uniserial limb of these forms. The innervation of these fins is also segmental. The pectoral and pelvic girdles, according to Balfour, are at first integral anterior parts of the basipterygial plate and become segmented off afterwards from the basipterygium. The coracoid and pubic are then developed still later in a proximal direction as continuations of the scapula and ilium. Dohrn's researches therefore enable us to complete the theory of the paired limbs of Elasmobranchs, and lead us to the conclusion that such a biserial limb as that of *Ceratodus* is merely the result of the concrescence of primitive segmental rays or embryonic actinophores from behind and from before instead of from behind only, or possibly the middle or axial actinophore is composed of the bases of a lateral series fused together and secondarily segmented. At any rate, it would not be surprising to find that when the development of *Ceratodus* is known that it had almost continuous lateral fin-folds, along the whole length of which actinophores were developed, one actinophore of the series in each paired fin being accelerated in growth longitudinally to form the axis of the limb, and, as the fin gradually became pedunculate, carried its anterior and posterior serial fellows outwards along with it. The primitive character of its skeleton, the cœlacanthous structure of its median arches, interspinous bones, its cartilaginous biserial and multiradiate paired fins, and its simple skull are remarkably embryonic in every particular, and contrast in the most remarkable way with its specialized breathing apparatus. Some such manner of development as described above, if it somewhat exaggerated that which is figured by Balfour (Comp. Embryol., II, 505, Fig. 348) as obtaining for the pectoral skeleton of an embryo of *Scyllium stellare*, might lead to the evolution of a fin like that in *Ceratodus*, without any very extensive anterior coalescence of the segmentally-arranged actinophores of the fin-fold and lead to the formation of a biserial limb. At any rate, I would expect to find the lateral fin-folds of greater relative length in *Ceratodus* embryos than in most of those of the *Squali*, Crossopterygians, or Chimæroids, thus contrasting, but not quite so decidedly, as the fin-folds of these latter contrast in length with the short, paired fin-folds of Teleosts. This last contrast is in accord with the conclusions to be drawn from the facts of embryology generally, as to the highly specialized character of the Teleosts when compared with other groups of fishes. Pronounced reduction in the length of the lateral fin-folds of Teleosts has occurred, so that we should not expect to find in

their embryos any evidence of continuous fin-folds as I have already urged elsewhere,* so greatly does heredity influence and directly mar the potency of remoter ancestry, so as to induce a defective repetition of the phyletic history in the course of ontogenetic development.

The posterior paired fins or ventrals of Teleosts also develop from horizontal folds (*Salmo*), and there is no evidence to show that their plan of evolution is much different from that of the pectorals; at any rate, no elaborately-contrived archipterygium or ichthyopterygium hypothesis can give us the slightest aid in settling what must be determined by actual investigation. While there is much reason to regard not only the pectoral but also the pelvic fin of *Ceratodus* as very archaic, it is not certain that its very primitiveness may not be correlated with the primitive character of the median diphycercal fin system, and there is much reason to regard the Elasmobranch paired fins as more specialized, while those of the Ganoids and Teleosts are even more so, since the latter rarely have a prolonged peduncle, but, on the contrary, a very short one, the osseous elements of which are much more decidedly included by the soft parts of the body walls. The pro- meso- and metapterygial elements (fused actinophores, or the separate actinosts of Teleosts) which are the undoubted partial homologues taken together of what is the basipterygial plate in Elasmobranch embryos, which afterward subdivides into the three proximal pterygial pieces, which are evidently related, not to as many somites, to judge from what we know of their evolution, but each consists of several coalesced elements derived from as many somites. Not so in the case of the actinosts of Teleosts, which evidently consist, perhaps exclusively, of derivatives of far fewer somites than the basipterygium of the Elasmobranch embryo, as we know from the fact that so few somites enter into the formation of their paired fin-folds. While it is true that a secondary segmentation of the pterygio-coraco-scapular plate occurs in Teleosts during a late stage there are forms in which it retains the form of a chondrified plate, which does not develop either an osseous scapula or coracoid, but persists, as in the larva, as a cartilaginous lamina, with which the pectoral rays articulate directly (*Gastrostomus* and ? *Eurypharynx*). It is therefore clear how deplorably hopeless the attempt must ever remain to determine such homologies by consulting adult structures alone, if it is desired to follow the metamerism of the embryo as a basis for their determination.

We may now glance backward and see what conclusions we may legitimately draw from the foregoing discussion of the facts. It is evident, in the first place, that there is a metameric relation between the actinophores of the fin-rays of the paired fins. In the second place, it

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*Development of the Spanish mackerel (*Cybium maculatum*), Bull. U. S. Fish Commission I, 1881, pp. 160-161; Contrib. to the Embryography of Osseous Fishes, Rep. U. S. Fish Commission, 1882, p. [64] or 518.

is evident that various displacements have occurred,* due to growth, accompanied by a coalescence in the peduncular region of the basal actinophores of the paired fins, which has obscured the homologies of their parts and also developed the coalesced series of paired nerves so as to develop the plexuses which innervate the limbs.

The evidence of metameric or serial homology in the unpaired fins is too palpable to need serious discussion, for we find one spine bearing accessory radii to correspond with several somites (dorsal of *Polypterus*), or one spine or ray to each somite, or two or even three or even more to a single somite. This is the clearest possible proof, and goes far to supplement the ontogenetic evidence respecting the metameric origin of the basipterygial elements of the paired fins.

The case of the dorsal of *Polypterus* is a remarkable one, and has puzzled me greatly until recently, when I noticed that the strong, bony, anteriorly enamel-covered spines, with their posterior accessory rays, were probably not homonomous, or all derived from a single segment, but probably homodynamous, as Gegenbaur would express it, or serially homologous, according to Owen. This becomes evident in the light of the ontogeny of the basipterygium, as worked out by Balfour and Dohrn, for we find that the principal spines are homonomous with about every fourth vertebral spine, so that about three intervening spines do not apparently support rays or spines, and are thus without homonyms; but in view of the way in which the principal spines support accessory jointed radii posteriorly, it is probably fair to conclude that these accessory rays are the homonyms of the intervening apparently spineless segments between the great spines, and that in the course of development the bases of the accessory rays have been shoved forward out of their original relations with these segments, as the posterior actinophores of the pectorals of Elasmobranchs have been, and crowded up against the principal anterior ones and carried up and away from the body as these grew in length. The process is therefore one which in all probability is perfectly parallel with that involved in the production of the so-called archipterygium, so that the primordial continuous system of median dorsal homodynamous rays has been interrupted in *Polypterus* so as to develop discrete dorsal finlets by a process of proximal concrescence of sixteen short series, consisting of about four to five rays each. The foregoing hypothesis of the true nature of the dorsal of *Polypterus* we may, I think it probable, confidently expect to be confirmed by ontogenetic research.

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* See my remarks upon the rotation of the pectoral of *Gadus* upon its base (Contrib. Embryog. Osseous Fishes, pp. 66, 67). It is evident that such a rotation does not take place so soon in Elasmobranchs. The base of the fin in them permanently occupies a more primitive position or one which is much less different from the direction of the original fold. This is especially noteworthy in the Rays, in which the base of the pectoral of the adult undergoes almost no alteration of position in relation to the position of the fold from which it is derived. (See Wyman's memoir on the development of *Raia batis*.)

Supplementary evidence of the occurrence of serial concrescence of the radial supports may be found in the median fins of other fishes, as it is very strongly marked in the dorsal and anal of the adult of *Mola*, in which both neural and hæmal spines and interspinous elements are crowded together and pushed forward posteriorly and backward anteriorly so as to condense these fins in an antero-posterior direction, so that their bases are little more than half as wide as they would be had no such distal approximation of their supports occurred. In consequence of such concrescences the primitively-continuous median fins are shortened, as in this case, or interrupted in other cases, in the same manner as the lateral ones have been by the concrescence of their anterior and posterior segmental elements into a pectoral and ventral fin. This fact does not, of course, discountenance the actual abortion of some of the segmental radial elements which so frequently occurs, as any one knows who has noticed the wide eradiate intervals between the caudal and dorsal and the anal and caudal in the skeletons of numerous species of Teleosts.

This same kind of proximal concrescence occurs in the tail of Salmonoids, according to the investigations of Lotz (Pl. III, Fig. 4), where certain hypural elements originally distinct are shown to be in the act of coalescence. While it is true that in many cases actual concrescence of the hypural elements does not occur until ossification has been established in the course of nearly completed development, I believe that the origin in part of the diverging system of hypural bones and radial elements of the caudal of heterocercal Teleosts is to be rationally accounted for on the basis of this principle, just as the diverging system of rays of the paired fins is obviously to be similarly explained. It may be that in the case of the Teleosts the urostyle, which is included by the soft tissues of the tail, may be exserted beyond the hypural bones for this reason, as seen in Salmonoids (Pl. III, Figs. 1–4); that in fact the more posterior hypural elements, as they are successively developed from chondrifications which take place in the median skeletogenous tract, are shoved closer together basally than distally, so as to leave a longer portion of the end of the chorda projecting than would have projected had the bases of the hypural pieces been enabled to maintain their normal position in the straight condition of the chorda. This, I think, will be evident to any one who will take the trouble to compare the stages of development of the Salmon (Pl. II, Fig. 3) with the condition of the tail of the adult (Pl. VI, Fig. 2), copied from Lotz.*

According to this view the notch marking the distinction between the dorsal and ventral lobe of fish larvæ in the act of becoming heterocercal acquires a new significance. The epiblast is, in fact, shoved in at this point somewhat in the same way as the post-pectoral epiblast is shoved in at the hind part of the pectoral fold of Elasmobranchs, so as

* Ueber den Bau der Schwanzwirbelsäule der Salmoniden, Cyprinoiden, Percoiden und Cataphracten. Zeitschr. wiss. Zool., XIV, 1864, pp. 26, Pls. X–XII.

to crowd the actinophoral elements together to form the basipterygium. This gradual crowding together of the hypural elements and the proximal ends of the rays is well shown in seven figures of the young of *Atherinichthys notata*, Günth., given by A. Agassiz in Part III of his paper *On the Young Stages of Osseous Fishes*, Plates X and XI, where the advance inward of the dermal fold just spoken of is also well shown.

There are instances, however, in which so much of the dorsal lobe projects posteriorly as to really constitute what we have called an opisthure, as in *Lepidosteus* and *Gasterosteus aculeatus*, Linn., where the terminal caudal somites, with their included metameric skeletogneous tracts, are wholly absorbed, whereas in most Teleosts what corresponds to the opisthure of the preceding species is included more or less completely by the tissues which enter into the formation of the permanent tail. It thus happens that most of the primitive hypural elements in most forms are permitted to develop, but are much crowded together proximally so as to leave the urostoyle to project, in many cases permanently, and in almost all species during the very early stages, in the form of the upturned end of the chorda, which might, in its membranous condition, be called the *urochord*. In many instances amongst Teleosts degeneration or suppression of hypural elements has occurred, but even in these cases the loss in number has been small.

Those forms, such as the Salmonoids, which have the upturned end of the caudal vertebral axis more or less extensively segmented (Pl. VI, Fig. 2), are apt to develop rudimentary epural spines, which are homodynamous with the more anterior normal neural spines, as has been conclusively shown by Lotz. Distinct in their cartilaginous condition, they are finally covered with perichondrium, which becomes confluent, and ossifies to become the lateral "grosse Deckstücke" of Lotz. Such epural rudiments consequently become displaced more or less upwardly and laterally, apparently for the reason that the urochord is bent upwards so as to be shoved in between their homonomous basal halves.

In those forms which do not have the axis distinctly segmented beyond the bend of the urostyle it would seem that no epural spines are developed even as cartilaginous rudiments. J. P. McMurrich's criticism of Lotz, in his *Osteology of Amiurus* (Proc. Canadian Inst., Vol. II, No. 3, p. 298), as based on the latter form, is therefore entirely gratuitous, as there are never any epural cartilages developed on the urostyle of *Amiurus*, as in *Salmo*, as may be learned by examining Fig. 1 on Pl. IV, taken from the completely chondrified caudal skeleton of an embryo of *Amiurus albidus* fifteen days old.

What is true of the pectorals the writer has found to be true of the ventral fins of Teleosts in a number of widely-separated genera. In *Amiurus* the material of which the axial portion of the pectoral is formed consists of mesoblast continuous with the spongy connective tissue of the larvæ. In like manner the medullary substance which fills the epiblastic fold, from which the anterior dorsal is developed in

Amiurus, is continuous with the mesoblast of the skeletogenous investment of the notochord, by way of a thick band of mesoblast, which thus fills up a wide space between the lateral muscular laminæ of the opposite sides of the body. So far as it is possible to decide from very thin sections ($\frac{1}{1500}$ inch thick), no part of the epiblast takes a share in the formation of the primitive blastema, from which the proximal axial elements of the fin are derived, the corium, Malpighian, and epithelial layer not being involved in the formation of the basal actinophoral elements; the basal cartilages of the proximal ends of the rays, as well as the rudiments of the basilar interneural and interhæmal pieces of Cope, or median actinophores, being evidently laid down from mesoblastic rudiments.*

This evolution of cartilage actually occurs before the development of the ribs in cartilage and contemporaneously with the formation of a cartilaginous basal plate in the pectoral fold, upon which the divided osseous sheaths of the rays are afterwards superimposed. This basal or basipterygial plate *bp*, Fig. 5, Pl. X, becomes segmented distally into at least the basal cartilaginous nodular portions of the rays, there being no long basipterygial bar formed in the Teleosts, as in Elasmobranchs, but the proximal portion of this plate is thickened in some Teleosts, and this thickening doubtless represents the basipterygial bar of cartilaginous fishes.

The continuity of the tract from which the axial portion of the vertical fins are derived, with the skeletogenous investment of the notochord, shows that the mesoblast from whence the fin-rays and interspinous pieces are derived has a common origin with the former in the embryo.

The vertical epiblastic folds from which the unpaired fins are derived, are at first, throughout the whole fin-bearing series of the *Vertebrata*, as well as the larvæ of Amphibians, almost devoid of mesoblast; that layer being insinuated into the folds secondarily, either to furnish the material for the limiting walls of vessels or else to supply the material of which the basilar and all of the medullary substance included by the rays is formed. How much of the rays themselves are formed from without or by the epidermis, it is difficult to say, but the deposition of new material, we would, on account of the relations of the vessels, expect to occur from within or on the internal faces of the opposite halves of the rays. So that after all it is not so clearly demonstrated that the rays of osseous fishes are wholly of dermal origin, though their outer

*It may also be here stated that the medullary substance of the barbels of embryo Catfishes consists of mesoblast, and that shortly after the barbels have appeared, or about the sixth day of development, they contain a central cartilaginous rod, which appears contemporaneously with the cartilaginous elements of the larval cranium. The presence of cartilaginous internal supports in the barbels of larval Catfishes, as well as their extremely early appearance, as compared in these respects with the chin barbel of the Codfish and the labial barbels of the young Carp would indicate that these barbels of the *Nematognathi* appeared very remotely in the past in the ancestral form whence the modern forms are derived.

surfaces lie immediately against the epidermis, except at their bases, where it is apparent that more or less mesoblast intervenes between the ends of the proximal halves of the rays and the epiblast. Such is the case at least with the pectoral rays which are first laid down as dense homogeneous membrane, in the same way as the primary rudiments of the cranial membrane bones. A cartilaginous nodule (median actinophore) is also included by the proximal ends of the dorsal, ventral, anal, and pectoral rays, while the cartilaginous part in the caudal rays is the margin of the expanded hypural cartilages, which betray in the arrangement of the nuclei a tendency toward the separation of homologous nodules at certain nodal points near the ends of these pieces, though they probably never become discrete in consequence of the reduction and specialization which the elements of the caudal fin have suffered in the most specialized fishes. It is therefore evident that if the tract from whence the interspinous elements are formed is mesoblastic and cartilaginous, and at the same time continuous at one time with the nodules at the bases of the rays, that those basal elements are not truly of dermal origin. These facts, at least, indicate that the whole ray is not of dermal origin; or that only its lateral osseous halves developed in membrane can ever have had such an origin in the Teleostei.

The marginal bands of cartilage *b* Fig. 1, Pl. IV, at the ends of the hypural processes, and which are indistinctly differentiated by nodal aggregations of nuclei which resemble in appearance the arrangement of these bodies in the basibranchial plate or in the hyomandibular and symplectic bar at a time when the segmentation or sundering of these pieces into distinct elements is about to occur, is a striking fact, and one which leads me to think that the hypural processes are not simple. These nodal aggregations of nuclei are also found at the tips of the neural and hæmal spines of such Teleosts as do not have the dorsal and anal confluent with the caudal, and I am inclined to regard these terminal cartilages also as epiphysial elements, or rudimentary median actinophores which at one time were separate, but which have in consequence of a process of degeneration been suppressed. These rudimentary elements of the spines anterior to the caudal may be regarded as representing the nearly suppressed basilar interspinous elements, while those cartilaginous borders which we find to terminate the hypural pieces may be considered with some show of probability to represent the basal nodules or basilar interspinous pieces of the other developed median fins, for we find that the proximal ends of the caudal rays clasp this part of the hypural processes somewhat after the fashion in which the proximal ends of the dorsal and anal rays clasp the basal cartilaginous actinophores in the embryo.

The method of development of the parts of the segments of the median or unpaired system of fins is therefore very similar to that of the paired fins, as displayed in the course of their outgrowth. The continuity of the coraco-scapular cartilaginous plate with the basal cartilages of the

longer rays or actinophores of the pectoral shows how close this parallelism is.

The relation of the epaxial and hypaxial arches, in the course of their development, to the chorda, and the similar close relation of the paraxial processes, the ribs, to a spongy and reticular mesoblastic tract which invests the chorda and brain, and also extends upwards and downwards between the lateral musculature of the body in the middle line, and even shows itself in the vicinity of the pectoral at the time of its outgrowth, demonstrate very clearly that the belief in the doctrine that the whole skeleton is derived from an interstitial mesoblastic tract which is developed as a continuum over the chorda, the cerebro-spinal axis and also invests the muscular system, is securely founded upon observed fact.

Evidence of the occurrence of the process of concrescence, as observed in the limbs of higher forms, also exists, as may be gathered from the longitudinal section through the basal portion of the hind limb of a chick of the sixth day. The segments *s h l*, which afford the nerve supply and muscles for the hind limb, are evidently concrescing, as shown in Fig. 1, Pl. X. The sternal ends of the thoracic segments *s t* also exhibit such a tendency and seem crowded forwards. Other evidence on this point may be gathered from a paper by Miss Alice Johnson.*

Investigations such as these promise great results when applied to human and mammalian development generally. If the outgrowth of the limbs can be traced by means of microtomy through a sufficient number of stages, remembering also that more or less twisting or rotation of the limb-rudiment occurs during its outgrowth, we may be able to trace the nerves, blood-vessels, and muscles to their proper embryonic segments, formerly denominated protovertebræ, but now generally spoken of as somites by the more recent and more exact embryological writers. By the use of this method we may probably yet be able to say that the subclavian artery represents one of the intersegmental vessels of a young fish; that the complex muscular system of the limbs of higher forms is derived, as in the fishes, from the myotomes.

If also it is true that the proximal skeletal elements of the limbs of the lower forms are derived from a series of chondrifications belonging to successive metameric segments, then, inasmuch as it is probable that the higher forms have descended from the lower, the proximal elements of their limbs, humerus and femur, have probably also been derived from an originally compound structure made up of a series of metameric elements. This idea is to some extent countenanced by the existence of a separate series of proximal and distal epiphysial centers of ossification in the humerus of man. The epiphyses of the bones in higher

* On the development of the pelvic girdle and hind limb in the chick. Quar. Journ. Mic. Sci., and in Studies from the Morph. Laboratory Univ. of Cambridge, II, 1884, pp. 13-25, Pls. IV, V.

forms are probably suppressed axial segments of the limbs, which were probably functional in the limbs of lower forms. This view is further sustained by the fact that there is a tendency toward synostosis of many other elements of the skeleton in the higher forms, whereas their homologues in the lower ones remain distinct through life. In the light of such embryological research it will also become less difficult to understand the possible origin of a manus with more than three phalanges in each digit, as found in some Cetacea, of the development of which we know little or nothing relating to the bones of the limbs.

VI.—On the protopterygian stage of development of the rays in the fins.

As stated in another portion of this paper, it was proposed to discriminate a so-called lophocercal stage following that designated as the archicercal and characterized by the want of fin-rays as understood in speaking of the adult condition. A very remarkable kind of rays are, however, developed during the lophocercal stage of Teleosts which become most clearly marked just at its close, or when the permanent fins are about to be developed. These *embryonic fin-rays*,* as A. Agassiz has called them, were observed by C. Vogt about 1840 (and are alluded to) in his essay entitled *Embryologie des Salmones*, but they were positively shown to be connected with the formation of the permanent rays about twenty years since by Theophile Lotz† in a paper not devoted to the rays themselves, and the fact has therefore been apparently overlooked that to this author properly belongs the credit of having first pointed out that the filamentous embryonic rays stand in a genetic relation to the permanent rays which are derived from them. A. Agassiz nowhere in his several papers intimates that such a relation exists between the embryonic and permanent rays, although he has found the former in a great many genera of osseous fishes besides those in which they have been found by the writer, so that it seems probable that such rays will be found in the embryos of all *Teleostei*. Lotz found them in the young Salmon just after hatching immediately underlying the larval integument of that part of the median fin-fold which is destined to become the permanent caudal, but he says nothing of their more extensive distribution in other fins. It now remains for me to state (1) that these rays are first developed just beneath the epidermis of the fin-fold, Fig. 9, Pl. IX; (2) that there are two series, one under the right and the other under the left epidermic wall of the fold with some mesoblast insinuated between the two series, Figs. 4, 5, 6, and 7, Pl. IX; (3) they are, as pointed out by Lotz and Agassiz, very much more numerous

* Since this has gone to press the necessity of giving these elements a single name has become manifest to me, and in a later paper I have therefore named them *actinotrichia*.

† Über den Bau der Schwanzwirbelsäule der Salmoniden, Cyprinoiden, Percoiden und Cataphracten. Zeitschr. wiss. Zool., XIV, 2. Hft., 1864.

than the permanent rays, as shown in Fig. 1, Pl. IX; (4) these structures are found at about the close of the lophocercal stage in both the paired and unpaired fins and in the same relation to the integument in both, and form a perfectly continuous series when the folds are continuous; (5) they either atrophy together with the atrophied portions of the median folds, or they persist as in the adipose fins of *Salmo*, *Amiurus*, &c., or they coalesce and become enveloped by a homogeneous substance (Fig. 10, Pl. IX) to form the permanent rays, or they become more or less covered by the mesoblast, and some finally atrophy; (6) they are perfectly homogeneous, as shown in Fig. 11, Pl. IX, and are in every respect similar, optically and histo-chemically, to the perichondrium as developed around the chorda, cartilaginous ribs, and spines, or the homogeneous hyaline membranes in which the membrane bones of fishes form and calcify.

The fact that these fibers coalesce proximally to form the matrix of the permanent rays in Teleosts is positive proof of the fact that the numerous horny fibers found in the fins of Chimæroids, Sturgeons, Plagiostomes, and Dipnoans, are almost exactly homologues of the osseous rays of the first mentioned, supplemented as such a conclusion is by the fact that in all of these, as shown by evidence gathered by Balfour, Günther, and myself, the relations of the fibers to the epidermis and mesoblast is fundamentally the same in all; that is, the fibers occupy exactly the same place in respect to the other tissues in the fin-fold as do the two halves of the rays of the fully-developed fins of Teleosts. The fibers being parallel, numerous, and developed in a form which develops a skeleton in a cœlacanthous manner at first, which in its later cartilaginous condition at the close of the lophocercal stage resembles more than any other the condition which is permanent in *Protopterus* or *Ceratodus*, leads me to the conclusion that this stage of the larvæ of osseous fishes may very appropriately be called the *Protopterus* or *Protopterygian stage* on account of the remarkably close resemblance of its fin-system to the archaic type of fins possessed by the Dipnoans, which unquestionably preceded the Teleosts in time.

We thus get a more satisfactory notion of the relation in which these forms stand to each other. And we must now, for obvious reasons, regard the rays of Teleosts as merely a more highly specialized condition which ontogeny has shown must have arisen from a stage which is permanent in the Dipnoans, forms strangely advanced in some respects while they have remained singularly embryonic in almost every other. We thus find that the parallelism which has been insisted upon as existing between Palæozoic forms on the one hand, and the young stages of osseous fishes on the other, by L. Agassiz and Vogt, and also by A. Agassiz, is warranted in its main features, when all of the facts are produced which ontogeny has to offer, though it is true that it will not do to push the comparison too far. We are also enabled to say with some certainty that the distal cartilages of the paired fins upon each side of which the

fibrous rays of the protopterygian stage terminate proximally are in all probability homologous for reasons which will presently be given. The theory that certain portions of the primitive median fin-folds degenerate in those forms which have intervals between the permanent fins, as insisted upon in another part of this paper, is now conclusively demonstrated by the fact that in the preanal fin-fold of the embryo Salmon, just after hatching, we find the fin-fibers of the protopterygian stage present, though this fin never develops, but is gradually lost, nearly vanishing after about four weeks. This fact indicates that the Salmon has descended from a form which had an unpaired fin in front of the vent, and that the development of rays went no farther in this fin than the formation of the two series of fin-fibers. I have not found any evidence amongst recent fishes, of the existence of preanal fins, though *Balistes* seems to have the ventral fins coalesced into what might at first be taken for a preanal fin, were it not that its rays are alternately elements of the pelvic fins of opposite sides, as shown by their close relation anteriorly to the falcate and greatly prolonged pubic bones.

The larvæ of *Chondrostei* are represented as having preanal fin-folds with embryonic rays, but the Elasmobranch larvæ which I have been able to examine do not seem to possess them. Inasmuch, therefore, as they are not constantly present in the larvæ of all fishes it is probably premature to insist that they indicate anything more than this, namely, that the preanal fin-folds have been inherited from forms in which they were functional; what these forms were we do not know.

The pectorals of young Rays (? *R. stellata*) one and a half inches long do not seem to contain any horny fibers, though they are abundant in all of the fins of young Dog-fishes (*Squalus*), considerably smaller, where they are present as very short fibers in the marginal part of the fins beyond the point to which the cartilage protrudes. In young Lampreys four inches long I have found no traces of them, the vertical fins in these being supported by branching rays consisting entirely of cartilage which extend nearly to the margin of the fin-fold. In prepared sections of Tadpoles three-eighths of an inch long no horny fibers are apparent in the median fins. The *Amphibia* and Marsipobranchs are accordingly excluded from that category, the larval stages of which are characterized by the possession of horny fibers in the fin-folds, since a protopterygian stage is found only in *Dipnoi*, *Chondrostei*, *Elasmobranchii*, *Holocephali*, and *Teleostei*.

The *Leptocardii* are also excluded from the above assemblage of forms since the development of their so-called fin-rays is entirely different from that of any of the branchiferous Vertebrates possessing fin-rays, according to the account given of their development by Kowalevsky.* They arise in this form from aggregations of cells which become thrust apart centrally by the appearance in their midst of a vacuole filled with

* Entwickelungeschichte des Amphioxus lanceolatus. Mém. l'Acad. imp. des sciences de St.-Pétersbourg, VII^e sér., t. XI, No. 4. (See especially p. 12, Pl. III, Fig. 39.)

fluid, so that the development of the rays is similar to that of the chorda dorsalis of the animal. They are probably of mesoblastic origin, while the fine embryonic fin-rays, the protopterygian stage of other Vertebrates, are interposed between the epiblast externally and more or less mesoblast internally. The development of the rays of the Marsipobranchs offers more analogy with that of *Amphioxus* than that of any of the other ray-bearing Vertebrates.

In most anatomical hand-books it is explicitly stated that the permanent rays are integumentary in their origin. Since I have again taken up the subject with the object of finding out the true state of the case by the help of more refined methods of investigation, I have reached a conclusion which, in some respects, is opposed to the one generally accepted. My sections of Salmon embryos show that while the embryonic rays are at first interposed in a single layer between the epiblast and mesoblast which has wandered outward into the epiblastic fin-fold, at a late period relatively these embryonic rays become invested by the cells of the lower layer of the integument formed from the mesoblast, seeming to sink into the latter as its cells multiply and surround these rays externally. But the phenomena which occur prior to the formation of the embryonic rays themselves are even more conclusive as showing that the larval integument or epiblast has little or nothing to do with the formation of the permanent rays.

If sections through the tail of an embryo fish are prepared at about the time that the lophocercal stage is almost fully developed, of *Lophius*, *Belone*, *Fierasfer*, and *Alosa*, for example, it will be found that the vertical fin-folds are filled with an homogeneous substance, as pointed out by Emery, which shows no traces of cellular structure, and contains no cells whatever, except sometimes a few in the basal part of the fold and near the axial mesoblast (see Fig. 10, Pl. X). Such cells evidently have wandered outwards. In the tail, however, where the embryonic fin-rays first appear, there is already an abundance of mesoblast, on either side of which the layer from which the embryonic rays are formed is placed. This layer seems at first to be very thin, as in Fig. 7*h*, Pl. X, and a product of mesoblastic secretion, in part at least, even should it be shown that what I have called pterygoblasts in the tail of the embryo Cod have no real genetic relation to the embryonic rays, which I am strongly inclined to think they must really sustain, on account of their form and relations to surrounding tissues, Fig. 3, Pl. IX.

The embryonic rays are therefore clearly dependent upon the mesoblast for their development, since it can be demonstrated beyond any doubt that as fast as they appear in the more anterior portions of the vertical fin-fold their advent is preceded or accompanied by the outgrowth of mesoblastic cells into the latter. The layer from whence the embryonic rays are formed seems almost homogeneous, and only as growth proceeds does it seem that the filamentous embryonic rays are differentiated from it. The pterygoblasts first disappear at the basal

part of the fold, and it would thus seem that the embryonic rays were formed from within outwards or in the direction of the migration of the tissue from which they are formed, which seems to be converted into the thin, nearly homogeneous membrane already spoken of, before these rays become distinctly differentiated as fibers which present a remarkable homogeneity of structure. Fig. 5, Pl. IX, shows how deeply the membranous rudiments of the permanent rays may become imbedded in the mesoblast at their proximal extremities.

The development of the embryonic rays between the epidermis and mesoblast of the folds which give rise to the paired fins is precisely similar to that which occurs in the folds from which the unpaired fins are developed, as may be gathered from a glance at Figs. 3 and 5 on Plate X.

VII.—What is it that constitutes a fin-ray?

As may be gathered from what has preceded upon the origin and development of the fin-rays, it becomes pertinent to inquire what it is that constitutes a true fin-ray. It may be said that true fin-rays, which are embryologically the homologues of each other, are formed only in the group distinguished under the name of *Lurifera* by the most recent taxonomists, a group embracing the *Selachii*, *Holocephali*, *Chondrostei*, *Holostei* (and *Ganoidei* generally), *Dipnoi*, *Physostomi*, and *Physoclysti*. It is also a fact that the development of the first traces of the rays is approximately the same; that is, they are first formed just under the larval integument or epiblast (the epidermis of the adult) in all of these forms. In no case are they certainly known to develop in cartilage. The apparent exceptions to this statement, such as the cartilaginous radii found in the fins of the Rays, it must be borne in mind are in no sense the homologues of the horny rays of a form even so closely allied to them as the Sharks, because these radii of the pectorals, for example, in the Rays, are the exact homologues of the cartilage cut across in the Salmon's pectoral, *bp* in Fig. 5, Pl. X, or that of the pectoral, Fig. 3, *cr*, Pl. X, of *Scyllium*. The *cartilaginous rays or actinophores of the Lyrifera develop in the central, axial, or medullary mesoblast of the fin-folds in both the paired and unpaired fins.* These elements may be segmented into basilar interneural, interneural, basilar interhæmal, and interhæmal elements in the paired fins, or even be partially or wholly wanting where the morphological differentiation of the fin has not advanced much beyond an embryonic condition, as in the case of the adipose fins, for example; or they may be more or less suppressed by other causes, such as degeneration in the caudal region, and fused together, as elsewhere stated. In *Polypterus* the dorsal finlets show evidence of concrescence and a tendency towards the formation of a uniserial structure with a loss of the basal elements of the concresced rays. In the paired fins of *Dipnoi* these axial cartilages may be reduced to a single tapering multisegmented bar, as in *Protopterus*, with a few short lateral elements

articulating with its basal portion. In *Ceratodus* they are the biserial cartilaginous axis of the limb. In *Polypterus* they are the anterior and posterior basal elements of the limb with intercalated elements intervening. In *Chondrostei* they are the segmented cartilaginous basal plate which subdivides distally into six bars.* In *Elasmobranchii* the axial plate of the paired fins is more complex, and usually consists of three well-marked subdivisions arbitrarily named pro- meso- and metapterygium,† external to which there is a greater or less number of segments resting upon the preceding three pieces, with a more or less parallel course, though often diverging and dividing, as in the Rays, for example. The Torpedo has a so-called cephalic fin resting in part upon antorbital processes and partly on the cranial rostrum. These are the principal forms of the axial skeleton of the paired fins. They are the most primitive and embryonic representatives of the limb skeleton found amongst Vertebrates, as embryological research has shown.

In the Teleosts, where great specialization and even loss or shifting, of the posterior fins have taken place in some forms, still greater reduction has occurred. The axial‡ basal elements of the pectoral may be present as a single plate (*Gastrostomus*), or, at most, be represented by a few short (usually three or four) actinophores, often supporting a greater number of rays. The group *Actinopteri* of Cope (*Teleostei* of this paper) is thus defined by its author: "Derivative radii few in the fore-limb, sessile on the scapula; wanting or very few and rudimental on the hind limb, so that the dermal radii rest on the axial element." It is therefore evident that the Teleosts represent the extremest term of specialization attained by the limb-skeleton in fishes, and that in the pelvic limb, at least, the whole limb is sometimes represented by true rays only. *In all of the Lyrifera the axial skeleton of the paired fins is developed from the middle or medullary part of the mesoblast, which is thrust out into the primitive epidermic or epiblastic lateral fin-folds*, just as in the case of the unpaired fins, but there is not that palpable continuity of the skeletogenous tract of the paired fins with that investing the chorda, as in the case of the same tract in the unpaired fins.

The next point of great morphological and theoretical importance in the definition of the true rays is their primordial relation to the axial skeleton of the fins. We found that the latter originated in the central parts of the mesoblastic substance of the embryonic fin, whereas the true rays we find to originate in the superficial part of the same layer,

* Vide Günther: Memoir on Ceratodus. Philos. Trans., II, 1871, p. 533.

† Vide Huxley: Anatomy of Vertebrated Animals, p. 38.

‡ The term *axial elements* is here used to signify the endoskeleton of the whole of the mobile portion of the limb, and not to signify the endoskeleton which forms the proximal elements or segments of the pectoral and pelvic limbs of fishes, as implied by Cope in the phrase "axial series" in his paper in Proc. Am. Philos. Soc., May, 1877, and Report of State Commissioner of Fisheries of Pennsylvania for 1879 and 1880, pp. 67, 68. This explanation has been thought desirable in case the reader might be led to compare this memoir with those by Cope.

or that next the epidermis, or simply between the latter and the underlying mesoblast, especially the distal and least modified portions of the rays at the margins of the fins. This relation of the rays to the primary embryonic layers has led writers to speak of them as exoskeletal in contradistinction to the other portions of the skeleton, named endoskeletal, for the reason that the stratum which they at first overlie subsequently becomes the corium and a part of the adult skin. But it so happens that very young or larval fishes have no corium or true deep layer of the skin developed, and that proximal portions of the rays soon become quite as deeply imbedded in the mesoblast, even below what can ever become corium, as a considerable part of the clavicle, for example, the membrane of which also lies at first very close to the epidermis in larval fishes. It is thus made evident that the distinction between the rays as exoskeletal as distinguished from the other hard parts called endoskeletal is really a forced one. Furthermore, phylogeny and embryology both indicate that the embryonic fin-rays are in reality the membranous representatives of the more numerous rays once possessed by the most ancient fishes.

The composition of the embryonic rays is the same chemically as that of the membranes in which membrane bones are formed, as is shown by the way in which they stain. A good many of the embryonic rays also atrophy, especially the ends of those lying at the bases of the fin-folds, in the intervals between the points where the permanent rays appear. This last fact is a further illustration of the common occurrence of the reduction of the number of homologous parts with the advance in specialization or evolution. The embryonic fin-rays are never distinctly developed as fibrils till the mesoblast has proliferated into the epiblastic folds from which the fins are developed, which is quite enough evidence to prove that they have as much right to be called endoskeletal as any other portion of the skeleton which develops in membrane imbedded in mesoblast.

The superficial or dermal position of the rays is, however, an important character, and one which is in striking contrast with the position of the axial or cartilaginous skeleton, but not so important when contrasted with the position of the points of origin of many membrane bones, which develop in a quite superficial position, such as the dentary and the upper part of the clavicle.

Another character, which is of some importance, is the proximal extension of the true rays. They uniformly terminate near the edge of the fins distally and proximally just over either side of the distal end of the axial skeleton in both the median and paired fins. Their mode of connection with the axial skeleton is also approximately the same in both kinds of fins; that is, the distal nodular elements or actinophores of the axial or basal cartilages become invested on their right and left sides by the basal ends of the right and left halves of the rays when the latter have been completely differentiated. In the case of those

forms, such as the Chimæroids and *Dipnoi*, in which the muscular and osseous segments are far less numerous than the homonomous rays, the inclusion of the distal nodules spoken of cannot be so complete. Such a condition also renders the muscular specialization much less marked and more like that observed in embryo fishes at the time the embryonic rays are formed. The erectores and depressores spinæ muscles are therefore not so distinctly differentiated as at a later period, as must obviously occur to the reader.

True fin-rays, as found in the *Lyrifera*, are never preformed in cartilage, and, widely as they differ in extent of development, the actinosts, as they have been called by Gill, as found in the pectorals of Teleosts, are homologous with the greatly developed pro- meso- and metapterygium of the Rays, together with the very elongate, numerous, often dichotomous, multisegmented cartilaginous radii which they support, provided they have in both cases been developed from the same number of serially homologous segments or somites, which are removed to the extent of the same number of segments from the occipital somite. This may be gravely doubted in some instances, as, for example, in the case of *Gastrostomus*, where the pectoral in the adult is homonomous with a segment or segments separated by at least fourteen from behind and beyond the occiput.

In the unpaired fins of Teleosts there is the clearest evidence that the rays are homonomous with the somites, and that from one to five or six rays are developed to a single somite, each ray involving the coalescence of a number of embryonic rays or fibrils which were developed in the embryonic fin-folds. This concrescence of fibrils, the evidence of which is given in Plate IX, is found to occur in all of the fins of all of the *Lyrifera*.

A fin-ray of the lowest of the *Lyrifera* may be formed of only two primitive fibrils to as many as twelve or even more, so that in the highest types the greatest number of primitive fibrils or embryonic rays enter into the formation of a permanent ray, so that the rays of the highest and lowest forms only differ in being respectively more or less complex in this regard.

The definition of a fin ray, which will hold for all of the *Lyrifera*, will be as follows: A horn-like or osseous rod formed beneath the embryonic integument (epiblast), and at first composed of fibers, a greater or less number of which become directly or indirectly blended to form a permanent ray, lying distal of the axial cartilaginous or osseous support of the fin in the superficial mesoblast, and invariably consisting, when ossified, of membrane bone, and always of more or less clearly defined right and left halves, formed in the right and left sides of the fin-fold, except when fused together into a hollow rod in the middle line of an early stage. More superficial ossifications may become blended with some anterior rays, as in *Nematognathi*, and lead to the develop-

ment of spines exaggerated in thickness by synostosis with such superficial hard or bony structures.

The term *horn* or *horny* as applied to the embryonic fin-rays is not justified even in the case of *Chimæra* and *Ceratodus*, or in the other instances where the embryonic rays retain their primitive character, as, for example, in the adipose fins of Salmonoids and *Nematognathi*. In *Chimæra* and *Ceratodus* we might naturally expect to find that the fin-rays exhibited embryonic features, when we bear in mind how embryonic and cartilaginous the skeleton has remained. *Ceratodus* seems, in fact, as if it were an embryo *Teleost* which had been permitted to lose its yelk-sack and grow large, meanwhile losing none of its embryonic skeletal characters, though acquiring others, such as a more differentiated respiratory system, but with the development of its tail arrested at a point nearly coincident with the end of the lophocercal the stage of the Salmon. Such an arrest of development gives to fin-skeletons of *Dipnoi* and *Holocephali* their peculiar traits, which so closely parallel the embryonic condition of Teleosts, so that their fin-rays, while partaking apparently of a horny nature, in reality have no very close resemblance to horn. As already stated, the horny fibers (embryonic rays) are similar to perichondrium histologically; it follows that the rays of *Dipnoi* and *Holocephali* are simply this perichondrium-like substance, which has grown in volume and suffered little or no calcification. Another reason why the rays of these forms, as well as those of embryos, are not comparable to horn is that the epidermis has little or nothing to do with their formation, while truly horny structures, such as nails and hairs, arise, in great part at least, by the direct cornification of the epidermis

The persistence of embryonic rays in the adipose fins of Physostomes is doubtless correlated with that other more embryonic condition of theirs, namely, the possession of an open pneumatic duct, which shows them to be less highly differentiated than the Physoclists, a group which, it should also be borne in mind, embraces the most specialized *Teleostei*, such as the *Lophobranchii*, *Hemibranchii*, and *Plectognathi*, the latter embracing the *Moloidea*, in which the caudal skeleton is more highly specialized than in any other fishes.

VIII.—Special modifications of the development of the fins.

In order to bring forward some of the forms of development of the fins or fin-like organs which it is difficult to account for, it has been thought advisable to devote a few paragraphs to certain modifications which are characterized by their exaggeration or extremely specialized mode of development.

The development of *Fierasfer*, which has been worked out by Emery, illustrates in a striking manner the statement that an extremely specialized but transitory structure may be developed in connection with the anterior part of the dorsal fin-fold. On first hatching an interruption

appears in the front part of the dorsal fin-fold, which is occupied by a papilla; by the sixth day this has been prolonged into an appendage nearly as long as the tail of the larva. At its base it consists of a short, rigid, vertical portion, to which is attached a long flexible filament, to the sides of which are appended alternately three ovate, flattened, pigmented bodies, of which the terminal one is largest. In the vexillifer stage, before the final metamorphosis into the adult, this flexible portion of the dorsal appendage may support as many as ten of these now nearly acuminate, flat, pigmented bodies. The base of this singular appendage consists internally of a rigid, homogeneous axis of connective tissue, in which no ossification ever occurs. In the vexillifer stage it finally has its base attached in front of the permanent dorsal, and disappears when the adult condition is reached.

It is clear that the development of this appendage is similar to that of a fin, being a very elongate diverticulum of the epiblast, into which pigment and connective tissue are proliferated from the mesoblast.

A somewhat similar development of long dorsal and ventral filamentous appendages or rays, bearing opposite bract-like processes placed at intervals, occurs in the case of the young of *Trachypterus*, two to four inches long, which seem to be aborted and lost during later life. In *Fierasfer* the vexilliferous appendage is not the rudiment of a true ray, but in *Trachypterus* the basal portions of these filaments seem to be retained as rays.

The development of the tail of *Trachypterus* is, however, not a little singular. In the young of the size mentioned above, it is homocercal, and, if the existing figures are reliable, it is structurally heterocercal. Subsequently, however, the longest rays of the caudal assume an upright direction at right angles to the axis of the body, while a few short hypaxial rays arise from the hinder and ventral border of the knob-like swelling which terminates the tail. The development of the tail of this group is evidently widely different from that of other forms, and it is not a little singular that the change of direction of the principal rays of the caudal should apparently occur during the post-larval period of growth.

The remarkable *Stylephorus chordatus* must also be considered in this connection, since it presents the peculiarity of having a body only 11 inches long, with a caudal band-like appendage 22 inches in length. "The caudal is directed upward, and has its rays connected by a rather firm membrane; the tail terminates in a narrow band-like appendage, about twice as long as the body." (Günther, Cat. Fishes Brit. Mus., III, 307.) This "band-like appendage" is undoubtedly homologous, as far as one is enabled to judge from Shaw's figure,* with the caudal filament of *Chimæra monstrosa*, or, in other words, the opisthure of *Stylephorus* is 22 inches long. This appendage of *Stylephorus* is below the upright five-rayed caudal, which it seems to me is not such, but prop-

* Naturalist's Miscellany, VIII, pl. 274.

erly the last portion of the dorsal, which is differentiated into three portions. There seem to be no anal rays developed.

The development of the Goose-fish or *Lophius*, according to the account given by A. Agassiz,* is one of the most extraordinary yet known to embryologists, and throws a great deal of light upon some of the problems which this study has suggested, especially in relation to certain questions which arise in the consideration of the genesis of the ventral or pelvic fins and their genetic collocation with certain mesoblastic segments posterior to the pectorals, and far behind those with which they are in apparent relation in the adult.

In the youngest stage figured by Agassiz the pelvic fin arises as a flat, lobate fold, some distance behind the pectoral fold, Fig. 1, Pl. XI, of nearly the same form and nearly synchronously with it. In the next stage, Fig. 2, it is represented as arising below the base of the now widened pectoral, as an elongate, spatulate process, arising from the side of the yelk sack, with a blunted, somewhat swollen tip. In the next stage it has become somewhat longer, more swollen at the tip, and its base more advanced, Fig. 3. As development proceeds its base advances a little more in front of the point of insertion of the base of the pectoral. The single first ray of the pelvic fin then buds out a second ray near its base, and the first ray, which is now more elongate, becomes somewhat geniculate and swollen in the vicinity of the bend. Its rays by this time, Figs. 4 and 5, far surpass in length those of the pectoral, which are now only beginning to develop. The rays of the pelvic fin now continue to precociously lengthen until the outermost one is nearly twice the length of the animal from the snout to the end of the tail, the total length being 30^{mm}. The bases of the pelvic fins are now clearly in advance of the bases of the pectorals.

This change in the position of the bases of the pelvic fins, if we keep in mind the successive events which are mentioned above, would seem to be due to an actual shifting forward of these fins from their original position in close homonomous relation with mesoblastic segments behind the pectorals. The jugular position thus assumed by the pelvic limbs of *Lophius* during its early stages might readily affect their final relations with the spinal nerves, and become innervated by pairs anterior to those which appertain to the segments in direct relation with its first rudiment when that was still behind the pectoral. Haswell's† foot-note, in his paper on the Elasmobranch skeleton may, therefore, lose its force if the preceding view is well founded. He says: "I have ventured (On the structure of the paired fins of *Ceratodus*, Proc. Linn. Soc. N. S. W., Vol. VII, p. 10) to make the very obvious suggestion that the derivation of the pectoral and pelvic plexuses from a number of spinal nerves was a strong piece of evidence in favor of

*On the young stages of Osseous Fishes. Part III. Proc. Am. Acad. Arts and Sci. XVII, 1882, pp. 280, 285, Pls. XVI, XVII.

† Proc. Linn. Soc. New South Wales, IX, 1884, p. 82.

Balfour's theory and against that of Gegenbaur; but I am now inclined to think, in view of certain facts observed by Fürbringer (Morphologisches Jahrbuch, IX) as to the origin of the nerves supplying the pelvic fin in some *Teleostei* with thoracic or jugular pelvic fins, that the portion of the spinal nerves from which the plexuses are derived is too plastic a factor to support any wide generalization at all." At any rate, the only way to settle this question now is to investigate some such form as *Lophius* and trace the genesis of the innervation of the pelvic fin by the embryological method, to see if the nerve supply of that fin is derived from the segments with which its first rudiment was homonomous, or whether its nervous supply originates from segments in advance of those from which it was derived. There is, for obvious reasons, little hope of settling this point by the method of comparative anatomy or the comparison of the morphology of adult forms.

Agassiz' figures also show that there are at most but four myotomes interposed between the early rudiments of the pectoral and pelvic fins, a number which is far less than in the case of the Salmon, where there are about sixteen, or four times as many. We thus find that the tendency to develop the pelvic fins is in some cases conspicuous at a very early stage. In *Gadus* the rudiments of the thoracic pelvic fins evidently do not appear until after the yelk is absorbed, judging by the results of my investigations on the early stages and those of Agassiz on the later ones. In *Motella* (*Onos* of Ayres) the development of the pelvic fins is about as nearly synchronous as in *Lophius* according to Agassiz, and the translocation forwards of the base of the pelvic fins probably occurs in much the same way.

In a larval pelagic form of Flounder from the Mediterranean, named *Peloria rüppelii*, by Cocco and studied by Emery,* the pectoral is remarkably pedunculate before asymmetry begins to show itself, and the ventrals are pushed forward in advance of the base of the former. The four anterior rays of the dorsal are also free at the ends and much exserted, a condition which appears to be evanescent, as in the case of the young of *Trachypterus*.

The embryological data so far acquired seem to indicate that the rudiments of the pelvic fins of the embryos of forms with permanently abdominal fins are not translocated forward during development, while in those forms which have thoracic or jugular fins such a translocation actually occurs. While nearly all of the Palæozoic Ganoids had the pelvic fins abdominal in position, some, as *Blochius*, for example (if that form is really a Ganoid), had them almost jugular, which would seem to indicate that such a translocation of the pelvic limb occurred relatively late in the history of the evolution of the fishes. The *Physostomi* also being the most primitive type of Teleosts, have mostly retained the pelvic fins in the archaic abdominal position, whereas the more highly

* Contrib. all' ittiologia. Reale Accad. dei Lincei. Classe di scienze fisiche, math. e naturali, XIV, 1883.

specialized *Physoclisti* have either generally had the rudiments of the pelvic fins translocated during development, until in some Ophidioids they are submental in position, or have had them quite aborted. The development of the pelvic fins, as well as that of the air-bladder in the *Physoclisti* indicates that they are more differentiated forms than the *Physostomi*, from which they have probably been evolved.

It may also be pointed out that the shifting of the position of the hindermost pair of fins is quite in harmony with the views of Balfour and Dohrn, and the mode in which the antero-posterior concrescence of homodynamous elements occurs at the bases of the fins, as well as their more or less extensive rotation, apparently over their own insertions, goes very far towards giving us an insight into the way in which the complex brachial and sacral plexuses have been developed by the anastomosis through the antero-posterior concrescence of paired spinal nerves.

We now come to the consideration of another set of phenomena which are of great importance in the development of a theory of the fins. What is now referred to is the peculiar way in which the spines or unjointed rays of certain forms develop. It is unfortunate that we are not familiar with enough forms to enable us to generalize with more certainty; but, thanks to the researches of A. Agassiz, we are enabled in the cases of two species which have the anterior dorsal spines forming a disconnected series, namely *Lophius* and *Gasterosteus*, to reach the interesting conclusion that such spines are developed in a great measure independently of the continuous folds and in a special way, that is, by the precocious outgrowth of a hollow terminally blind diverticulum of the epiblast, in which such spines are formed from the mesoblast.

In *Lophius* the first spine of the anterior dorsal appears as a depressed conical mesoblastic thickening overlying the front end of the spinal cord, as in Fig. 1, Plate XI. In the next stage the epiblastic diverticulum is pushed out and the first indications of the first dorsal ray have appeared, as in Fig. 2, Plate XI. The vertical median fin-fold now atrophies more and more, and in the next stage, Fig. 3, Plate XI, the medullary portion of the process seems to be differentiating in which subsequent ossification is to occur. In the next stage, Fig. 4, Plate XI, two dorsal rays are visible, and in the next, Fig. 5, four may be distinguished.

In *Gasterosteus aculeatus* the researches of Agassiz show that the rigid anterior spines are also formed as more robust distinct papilliform outgrowths of the epiblast into which mesoblastic tissue is at once pushed out, while the hinder rays of the dorsal are formed in a continuous fold in the usual way, embryonic rays being first formed. The spines, however, do not in either *Gasterosteus* or *Lophius* seem to be preceded by embryonic rays. Such spines are therefore probably developed from the basement membrane, which doubtless forms in the mesoblast which grows into these epiblastic papillæ or diverticula,

and ossifies directly. The anterior dorsal spines of *Gasterosteus* do not seem to be preceded by a median fold, the latter having atrophied before the papillæ which develop into the dorsal spines have begun to grow out. In *Cyclopterus* also no median fin-fold seems to precede the anterior dorsal; a thick, low, hump-like outgrowth in front of the dorsal fin-fold, leading to the development of the anterior dorsal directly. Embryonic rays may possibly precede the formation of the permanent rays of the first dorsal in *Cyclopterus*, judging from Agassiz's figures.

It will thus be seen that the modes of development of the anterior dorsal spines of *Lophius* and *Gasterosteus*, and the vexilla of *Fierasfer* are similar, and that such a specialized mode of ray-development tends to bring about the suppression of the fore part of the more archaic, dorsal median fin-fold; that it also tends to lead to the suppression of the embryonic fin-rays, which in all probability take no share in the formation of the anterior spines in such forms, but retain such a relation to the permanent rays only in the posterior dorsal, anal, and caudal, and the soft rays of the pectoral and pelvic fins.

The rays of the pelvic fin of *Lophius* are in like manner evidently not derived from embryonic rays, but seem to be formed like those of the anterior dorsal.

These extreme forms of specialization lead us to anticipate other equally singular modes of ray-development, which will probably only differ in detail, because we find after all that the principle upon which both kinds of rays develop, namely, the separate form and those conjoined by a membranous investment, is essentially the same. The first are formed in distinct epiblastic pockets of the skin, the latter in continuous or confluent ones, or in what I have throughout this paper called folds.

I have already referred to the peculiar way in which the rudiment of the pelvic fin is pushed forward in *Lophius*, but I must also call attention to the fact that an actual pushing forwards of the anterior dorsal also takes place in this form, as a result of which the first dorsal ray is finally brought to rest upon the frontal bones of the skull in the adult. In *Malthe*, according to Gill, who has called my attention to the fact, the anterior dorsal is shoved still further forward than in *Lophius*, this peculiarity being recognized as a family character by Gill in these words: "Anterior dorsal ray in a cavity overhung by the anterior margin of the forehead." In Fig. 1, Pl. XI, the rudiment of the first dorsal ray of the embryo of *Lophius* appears above the anterior end of the medulla spinalis and behind the medulla oblongata, but in some way it is slowly advanced until, in Fig. 5, its base is above the mid-brain. A new dorsal ray, according to Agassiz, next appears more anterior to the one first formed, which may explain in another way how the advance forward of the most anterior rays of the dorsal is accomplished by their development as later, single, and more anterior outgrowths. There is, nevertheless, positive evidence that the originally formed

dorsal rays have been pushed forward in the young, though the most anterior dorsal rays resting on the head of the adult above the snout may have been developed during post-larval life. This peculiarity of development is approached by the fore part of the dorsal of Flounders, in the young of which, as development proceeds, the anterior dorsal rays are advanced so as to occupy a more anterior position in the adult than in the very young. Such examples of the displacement of structures forwards in the course of development would probably lend support to Gegenbaur's interpretation of the cephalic fin of Torpedo as a part of the pectoral which has been advanced and acquired support from the antorbital processes of the skull secondarily.

IX.—ON THE TRANSFORMATIONS OF THE TAIL OF MOLA.

(See Plate VIII.)

In 1870 F. W. Putnam* described the anatomical peculiarities of *Molacanthus nummularis* (Walb.), Gill, as compared with the young of *Mola rotunda*, Cuv. In the latter, Putnam states that he found "the neural spines of the fifth to the fifteenth vertebræ closely packed together with the interneural spines and extending backwards to support the dorsal fin, while the hæmal spines of the tenth to the sixteenth vertebræ are in close connection with the expanded interhæmal spines supporting the anal fin. The sixteenth vertebra gives off large neural and hæmal spines, the former having five interneural spines anchylosed [in contact] with it as in the adult, while the hæmal spine supports [or is in contact with, posteriorly] nine interhæmal spines, the lower one of which belongs to the anal fin, while the others are of the caudal chain. In the adult only seven interhæmal spines are connected with this hæmal spine. The seventeenth vertebra in the adult lies in the caudal chain of interspinous bones, and from its being separated from the vertebral column has been as often considered an interspinous bone as a vertebra. In the young specimens this vertebra, though separated from the column as in the adult, has in close connection with it two bones above and two below, probably indicating that this vertebra is in reality the consolidation of two vertebral bodies, the seventeenth and eighteenth, while two other small (neural and hæmal) bones posterior to this free vertebra indicate that a nineteenth vertebra existed at an earlier stage. These six neural and hæmal (three each) bones disappear in the adult, and with them the central rays of the caudal fin, and they and the seventeenth, eighteenth, and nineteenth vertebræ are represented only by the free or 'floating' seventeenth vertebra, which lies in the chain of *interspinous* bones of the *caudal*. This is the only instance of a vertebra existing as distinctly separated from the vertebral column, known to the author." * * *

"The skeleton of *Molacanthus* shows the interspinous bones of the dor-

* American Naturalist, 1874, IV, 629-633.

sal in connection with the neural spines of the fourth to the seventeenth vertebræ, and those of the anal with the hæmal spines of the tenth to the seventeenth vertebræ. The vertebral column in *Molacanthus* terminates abruptly with the seventeenth vertebra, and no caudal chain of interspinous bones can be traced. The liver is small, when compared with that of the young [*Mola*], and is composed principally of a large right lobe overlying the stomach. The stomach is small and the intestine is short, making but two turns like the letter S, while in [*Mola*] it is long and has five or six turns or coils. The arrangement of the muscles and bones of the head is in general about the same as in [*Mola*]."

These extracts from Mr. Putnam's article embody essentially all that he has added to our knowledge of the morphology of the young stages of *Mola rotunda*, as we will show all of them to be in accordance with the views of Lütken, Steenstrup, and Günther, but the position of those authors will be here fortified by conclusions based on another series of comparisons and on the general principles of development, which may be depended upon to clear up many facts of very uncertain significance when viewed merely in the light of the comparative anatomy of the adults.

Mr. Putnam does not seem to have thought of the fact that the differences which he had indicated as existing between *Molacanthus* and *Mola juv.* were just those differences which another investigator would seize upon, guided by the light which embryological principles would afford him, in order to show that *Molacanthus* was only a younger stage of *Mola*. Nor does it seem to have occurred to any one to look and see if the generative organs of *Molacanthus* were developed to maturity, or whether they were present only as *genital folds* or ridges of the peritoneum in the upper posterior part of the abdominal cavity, and therefore in an immature or larval condition. The recognition of *Molacanthus* as an adult form, therefore, rests on pure assumption, and cannot be demonstrated with the help of the anatomical data now at our command.

On Mr. Putnam's investigations the embryologist may very evidently base conclusions diametrically opposed to those entertained by that author. For example, in *Molacanthus* the intestine is short, and has but two bends, or is sigmoid in its course, while in the form thought to be the young of *Mola* the intestine is long and has five or six turns or coils. This is what should have been expected on embryological grounds, for the intestine of young fishes is always straight at first, and only becomes bent so as to develop more coils or loops as the form approaches maturity. The liver also develops unsymmetrically in many young fishes, and to urge its relatively smaller size in *Molacanthus*, as compared with *Mola juv.*, where it is more symmetrical and relatively larger, is simply to ignore the light which embryology might have thrown upon the matter, when all difficulty on this point would have immediately disappeared.

In the same way the differences observed in the arrangement and re-

lations of the interspinous bones of the dorsal and anal fins of *Molacanthus* and *Mola juv.* may be shown, without any doubt, to merely represent stages of development of the median pieces which support those fins. Tabulating the relationship of the interspinous neural and hæmal elements, as given by Mr. Putnam, this will become apparent.

Dorsal interspinous bones connected with spines of fourth to seventeenth vertebræ in *Molacanthus;* with spines of fifth to fifteenth vertebræ in *Mola.*

Hæmal interspinous bones connected with spines of tenth to seventeenth vertebræ in *Molacanthus;* with spines of tenth to sixteenth vertebræ in *Mola.*

The extension of the dorsal and anal fins posteriorly in *Molacanthus*, so as to be brought into relation with two more neural spines and one more hæmal spine than in *Mola juv.*, is very readily explained by the fact that these fins are, as a whole, apparently more posterior in position in the specimens of *Mola* still younger than the one figured as *Molacanthus* by Putnam, and that there is an apparent but not real wholesale shifting of the bases of these fins in a forward direction in order to reach the condition found in the adult, due to the outgrowth posteriorly of the caudal, in consequence of which the dorsal and anal are shoved apart. This line of argument is shown to be in the very highest degree the correct one, from the fact that in a very small pelagic fish, which has been called *Ostracion boops*, and now regarded by Lütken, Steenstrup, and Günther as a still younger stage of *Mola* than that represented by *Molacanthus*, the dorsal and anal fins are very closely approximated over the end of the body, so as to appear almost like the forked tail of a normal Teleost.

One apparent difficulty now presents itself with respect to the apparent shifting backwards of the dorsal fin of *Mola* to the extent of one neural spine farther to the rear in front, so that the first ray of the dorsal seems at first sight to be in relation with the spine of the fifth dorsal instead of the fourth dorsal as in *Molacanthus.* This difficulty, however, disappears at once when we find that in the adult the interspinous piece belonging to the fourth vertebra is really present, but is so closely appressed to that of the fifth as to seem at first as if it were a part of the latter. The dorsal spine of the fourth vertebra does not reach back to the corresponding interspinous piece, but is greatly depressed and lies partly in close contact with the upper side of the fifth vertebra in almost a horizontal position. It is evident that the interval between the posterior end of the spine of the fourth vertebra and its corresponding interneural piece has arisen in the course of growth, and is primarily due to the fact that the body grows rapidly in length anteriorly after the *Molacanthus* stage has been passed, so that the intimate connection of these elements would be sundered, so as to give rise to the interval between them as observed in the adult.

It is evident, therefore, that not a single one of these anatomical char-

acters which have been supposed to differentiate *Molacanthus* as the type of a family, subfamily, genus, or species distinct from *Mola* has the slightest taxonomical value, and much as the writer would desire to agree with Dr. Gill's* views in relation to these matters, he is forced, after carefully weighing all of the evidence before him, to arrive at a conclusion directly opposed to that of the above-mentioned distinguished authority.

That the little fish described by Sir J. Richardson† as "*Ostracion boops*" is in all probability the young of some form of *Mola*, or of a type closely allied, cannot be questioned, from the fact that the spines, while not as numerous as those distributed over the skin of the *Molacanthus* stage, yet agree to a certain extent with those on that form in their relative position, and also in the fact that they, as in the latter, have raised carina radiating from their apices, which are surmounted by rows of diminutive secondary spines. Certain it is at any rate that the form is not an *Ostracion*, because the two posterior fins are manifestly to be regarded as anal and dorsal, and not as "anal and caudal," as supposed by Richardson, for his figure 21 shows that there is a narrow interval between these two fins which is the homologue of the interval between the two corresponding fins of the *Molacanthus* stage.

Richardson's description of "*O. boops*" may be profitably reproduced in this connection:

"Radii: C. [D.]12; A. 14; P. 14 (Dr. Hooker). Being unwilling that any of the novel forms of fish sketched by Dr. Hooker should be altogether lost to science, though the specimens from which they have been designed have perished, we here present an Ostracion, in which the chief novelty appears to be the want of a dorsal fin. Dr. Hooker has given four views of this little fish in different positions, viz: [Pl. XXX, fig.] 18, a lateral view, [fig.] 19, a view of the back, terminated at each end by a long spine, and with two smaller intermediate eminences, which seem to replace the dorsal fin. Fig. 20 shows the under surface, when the fish is turned so as to bring the mouth and frontal spine into view, and [fig.] 21, the posterior surface, looking from the vent over the anal and caudal [dorsal] fin to the long caudal spine.

"*Hab.*—Taken in the Southern Atlantic in a tow net."

It is not stated in the original description by Richardson how much the figures are enlarged, but Günther says (Introduction to the Study of Fishes, p. 175) that Richardson's figure 18, which we have reproduced in the accompanying Plate VIII, Fig. 1, is "much magnified;" information which he may probably have obtained from Dr. Hooker himself. The great size of the eye would also indicate that the specimen was very young, and would lead the writer to think that the figure must have been drawn considerably larger than natural size. The front and top

* Synopsis of the Plectognath Fishes. Proc. U. S. Nat. Mus., 1884, 411–429.

† Voy. Erebus and Terror (Ichthyology), p. 52, Pl. XXX, Figs. 18–21. (Drawn by Dr. Hooker.)

views given by Richardson also show that "*O. boops*" is very thick in proportion to its length and height, much more so in fact than it is in either the "*Molacanthus*" or *Mola* stages of development; a fact which would also favor the conclusion that this represents a much younger stage, and therefore a smaller fish than the two latter. The two upper rows of spines on "*O. boops*" can be pretty closely homologized with those in the same relative position in the *Molacanthus* stage, but the three median ventral spines present along the median ventral aspect of both the *Molacanthus* stage and the very young *Mola* are absent in "*O. boops.*"

This close agreement in the distribution of the spines cannot be considered otherwise than indicative of the very close ontogenetic relationship of the three forms in question, and such a conclusion is still further strengthened by the fact that in all three the spines are apparently of cuticular origin. They are characteristic and persistent until the young *Mola* reaches a length of about two inches, when they drop off, leaving the skin nearly smooth, as in the adult, though the scars with raised borders where the spines were originally attached remain and occupy the same relative position in respect to each other as in still younger stages and that phase represented by *Molacanthus*.

The interval between the dorsal and anal fin of "*O. boops*" shows that even in this early condition of growth the *Molina* have no true caudal fin, or, at least, a caudal developed with intermediary neural and hæmal supports, such as are found in normal Teleosts. Yet it is clear that in the *Molacanthus* stage the first signs of what represents a caudal in *Mola* appear as very short rays included by a narrow fold of epiblast or skin, which grows in height as the rays lengthen, and approach the condition which they present in the young of *Mola*. But the development of the median caudal rays to a length exceeding twice that of the rays above and below them in young specimens of *Mola* shortly after they have passed the *Molacanthus* stage is very remarkable, since, as the fish increases in size, this tail-like extension of the middle rays of the caudal disappears, so that the margin of the whole tail-fin assumes a moderately convex or gently rounded outline when viewed from the side. This prolongation of the central rays of the caudal in the young *Mola*, however, assumes a striking significance when compared with another closely related adult form pertaining to the *Molina* first described and figured by Bleeker* and now known as *Masturus oxyuropterus* (Blkr.) Gill, which has the central rays of the caudal very much prolonged and slightly divergent, as in the young of *Mola*, the backwardly projecting central part of the tail being also armed with a pair of dermal plates. This condition of parallelism in the development of the central rays of the tail of the young of *Mola* and of the adult *Masturus* would indicate that the latter has retained in the course of its evolution a characteristic which is only a transient feature of the evolution of *Mola*.

*Med. d. Kon. Akad. Wetenschappen, 2de Reeks, Deel, VII, Amsterdam, 1873.

The prolongation of the central rays of the caudal of the young of *Mola* looks at first as if it represented the lophocercal prolongation of the somatic axis of the larva, but a careful examination shows that there is no prolongation of the chorda, nor is the skeleton extended in any way into this median projection of the caudal. If such is the case, sections alone could be depended upon to clear up the question, though I am very decidedly of the opinion that even sections will not show any evidence of rudiments of the chorda in this median posterior prolongation of the caudal fin. If any rudiments of a prolonged somatic axis are present, it is most probable that the chorda will be found present. This is a point which my researches cannot determine with certainty, since it is desired to preserve the materials now in my possession without mutilation for reference. Very careful examinations have convinced me, aided as I have been with an excellent triplet, that the embryonic axis or chorda is not prolonged into the central prolongation of the tail, already described, because this median extension is a secondary formation, and not a part of the primitive larval axis.

The morphology of the tail of the *Molina* cannot, however, be understood without making certain assumptions, which are unequivocally justified by the structure of the tail of the adult. We find, in fact, that the tail of the *Mola*, when full grown, is constituted of rays, which are supported entirely by interneural and interhæmal pieces, and not directly by any hæmal and neural spines. These, however, are indirectly brought to serve as supports for the interneural and interhæmal elements in a way which is without a parallel amongst Teleost fishes. The sixteenth vertebra has its neural and hæmal spines greatly prolonged, and the interneural and interhæmal elements of the caudal fin of *Mola* are proximally in contact with the spines of the penultimate vertebral segment.

The larva of *Mola* is not known, and it is therefore premature to do more than surmise, on the basis of the principles of comparative morphology, what that larva must be like. We find that the vertebral column of *Mola* ends abruptly with a "floating" vertebra, which is cylindrical in form and evidently does not represent the last bony segment as in normal Teleosts. The vertebral segments of *Mola* do not gradually become less in diameter in so striking a manner as in other Teleosts, so that the column does not terminate in an acuminate upturned urostyle, or in an attenuated extension of the chorda, as in normal forms. In *Masturus* it is not improbable that evidence of the greater posterior extension of the vertebral column will be found, as would be indicated by its longer caudal fin. It is evident, nevertheless, that a part of the larval axis of *Mola* has been suppressed, for the reason that the last vertebral centrum is but slightly smaller than the penultimate one, and has evidently been formed in the skeletogenous investment of the chordal axis of the larva far in advance of its posterior extremity in the youngest larval stage of development. The presumption, there-

fore, is that the larval axis was relatively much longer than that of the adult, and that it possibly had a lophocercal tail, or at least a caudal prolongation which was probably absorbed at an early period, somewhat after the manner of the tail of the tailless Batrachians, and for this reason the end of the primitive caudal axis has not become the support for the caudal fin as in other *Teleostei*. The development of a special mode of support for the caudal has consequently occurred, which has apparently been caused by the abortion of the posterior end of the primitive axial skeleton. This view of the facts is demonstrated beyond any doubt whatever when we find that the interneural and interhæmal pieces which support the caudal of *Mola* are serially homologous with the interspinous pieces which support the dorsal and anal fins, though the interspinous elements of the caudal are shoved out of position and are arranged in two confluent series above and below the osseous axis at right angles to the rows supporting the dorsal and anal. In Fig. 7, Plate VIII, I have attempted to show the caudal of *Mola* somewhat as it would appear if developed normally; the elements which now exist are represented in black, while those which have been suppressed are represented by shaded outlines. The extension of the chordal axis posteriorly beyond the "floating" vertebra is shown in dotted outlines, while the suppressed myotomes and skeletogenous material of the median vertical portion of the urosome is limited in front approximately by the two heavy, curved, dotted lines, with the arrows alongside. Four more interhæmal elements are shown to be developed, in the young, below the line of the vertebral axis than above it.

This diagram represents the structural condition with which we have to deal in clearing up the question of the origin of the tail of *Mola*. If the eleven inferior and the seven superior interhæmal pieces are now swung forward in the direction of the arrows and along the course of the heavy dotted curved lines, the interhæmal pieces will have their proximal ends brought against the posterior face of the neural and hæmal spine of the sixteenth vertebra. This must have been the case, for we have shown that the posterior portion of the axial skeleton has been suppressed, but the superior and inferior margins of the urosome have evidently been preserved so that the interhæmal and interneural pieces belonging thereto have developed, but no remains of the corresponding neural and hæmeal arches are to be found, so that we have the anomalous condition of the interneural and interhæmal supports of the caudal resting upon the neural and hæmal arches of a vertebra in advance of those which would have been developed with their corresponding homodynamous spines, had the posterior and axial part of the tail not been suppressed.

The hæmal and neural supports corresponding to the seven superior and the eleven inferior interspinous bones have failed to develop, apparently, because the skeletogenous tract from which they are normally developed was suppressed, together with the posterior part of the caudal

axis. The preservation of only a part of the marginal portion of the median skeletogenous tract from which the hindmost interspinous supports for the caudal are developed is without a parallel, except *Fierasfer*, so far as the author is aware, amongst fishes. These supports sometimes fail to develop, but the layer whence they are derived is present, as in *Chimæra*, for example.

How far is the foregoing theory of the structure of the caudal fin of *Mola* justified by what is known of the development of this fish? Since we have satisfied ourselves that *Ostracion boops* is merely a stage of the development of *Mola*, it is clear that that form has already advanced far beyond the condition of the larva which *must* be assumed to have had some traces of a complete caudal axis, for it already exhibits a condition approaching that of the *Molacanthus* form, with its two developed dorsal and anal fins, which have a slight interval between them.

The youngest *Molacanthus* stage hitherto figured has the dorsal and anal more approximated than the specimen figured by Putnam, or the one in the United States National Museum, which would indicate that a metamorphic process was in progress in the interval between *O. boops* and *Molacanthus*. This view is supported by the fact that the fin-fold, which appears in still older *Molacanthi*, is very narrow or low, and the fin rays which it includes are very short and feebly developed. In the next stage, Fig. 5, this fin-fold between the dorsal and anal has become higher, and the first indications of the production of the middle lobe, such as is found in the next older stage, begin to be apparent. It is thus made very evident that the development of the caudal in these fishes is a progressive process, and that it is remarkable and even unique in this one respect, viz, that all of the unpaired fins do not develop simultaneously as is usually the case with young Teleosts. This can only be explained on the theory already suggested, that the posterior part of the primitive axis has been suppressed, so that in order to develop a caudal at all a secondary and indirect mode of development has been necessary, in the course of which the remnants of the anterior median ventral and dorsal parts of the urosome still preserved have supplied the materials for the growth of the interspinous bones which support the caudal rays, but these portions of the primitive urosome have been drawn forward and included between the anal and dorsal. Then as the caudal grows out it manifests another singular tendency, viz, to develop a certain number of soft rays in its central prolongation which are subsequently suppressed in the adult fish, which is simply additional evidence in favor of the belief that these rays belonged to a dorsal and ventral series, at one time developed along the upper and lower margins of the urosome of some ancestral form, but on account of the suppression of the latter, have been carried toward the end of the persistent part of the axis of the existing derivative form in excess of the number which are permitted to persist as permanent rays.

Dr. Gill seems to lay especial stress upon the statement made by Putnam that there is no caudal chain of interspinous bones developed in *Molacanthus*, and that their absence justifies him in recognizing the form as distinct from *Mola*. Unfortunately this character becomes as completely valueless in the light of embryology as all the rest which have been used to define *Molacanthus* as a form worthy of family rank. As we have already shown, *Ostracion boops* has no developed caudal, while *Molacanthus* has only traces of it as very short and feebly developed rays; and inasmuch as interspinous bones are always developed upon cartilaginous bases in the form of bars, and since fin-rays may be developed while the interspinous cartilages are still very imperfectly formed, there remains no shadow of doubt in the mind of the writer that the interspinous bones or their cartilaginous matrices were still undeveloped in *Molacanthus*, or at least so imperfectly developed in Mr. Putnam's specimen as to be undiscoverable or very readily overlooked. It thus becomes very easy to regard *Molacanthus* as merely a stage of the growth of *Mola*, in which the development of the tail has been retarded owing to the extraordinary and unique modifications which the type form has undergone. I am, therefore, fully convinced that the absence of developed caudal interspinous bones in *Molacanthus* is merely a transient embryological character and absolutely worthless in taxonomy. Of this I am so certain, that I will venture to predict that when an examination is made by a competent anatomist, a condition of things approximately like that which I have described will be found to exist.

Fortunately, I have been able to verify the foregoing prediction, which was written as it now stands a week since. Upon cutting open the skin at the edge of the tail of a specimen of *Molacanthus* with extreme care, so as not to otherwise injure the specimen, I found the axial skeleton in place, and carefully exposed its parts. I found, as stated by Putnam, the interspinous bones, which support the caudal fin, very feebly developed, if not absent. The spines of the seven caudal vertebræ were developed, but the vertebræ themselves, as well as the spines, were feebly ossified, their bony matter being developed, as usual in young fishes, in a perichondrial and perichordal position, wholly dissimilar from the adult condition. The terminal or floating vertebral centrum is developed, and is very short and bluntly pointed, ending just within the margin of the fleshy part of the caudal fin, and so very near the base of its ray-bearing marginal fold that it is difficult to see how there would be room for caudal interspinous pieces. Yet from my examination I am not certain that when a specimen is examined with the more accurate and thorough method of microtomy, they may be found as minute cartilaginous elements. They must necessarily be minute, for the narrow triangular area occupied by them in *Molacanthus* is not quite a millimeter wide and five millimeters long. To judge from the very rudimentary condition of the caudal fin in the *Molacanthus* stage, we should

expect these elements to be rudimentary, or even wanting; but they doubtless primarily develop in cartilage, as in other forms. Their development has evidently been belated or retarded as compared with the other vertical fins.

The vertebral axis of *Molacanthus* is apparently very oblique and about parallel with the base of the dorsal, the interval between them being but two millimeters; the distance from this axis to the extreme ventral margin of the abdomen is seven times as great; so that here we have a character strong enough for the most enthusiastic taxonomist to avail himself of as a family character. But let us see if even this is of any value. The fact is that the axial column of *Mola* gradually assumes a more ventral position, *i. e.*, the abdominal contour becomes less prominent with the advance in age, so that the axial column is apparently shoved downwards, as may be seen upon comparing together figures of the skeletons of the different ages. This pushing down of the vertebral column is, however, more apparent than real, the fact being that the abdomen diminishes in height, as a result of which the vertebral axis seems to be pushed downwards. During this process the obliquity of the axial column also diminishes, so that its anterior is lowered more than its posterior end.

During the *Molacanthus* stage the skeleton of the tail bears every evidence of immaturity. It is soft and flexible, and not ossified as flinty bone, as in the adult. The chorda comprises the bulk of the axial column, and one can easily make out that the vertebral segments are only just distinctly formed. The part of *Molacanthus* which is comparable with what is the tail of the young and adult of *Mola* is very rudimentary; and since we now know that the volume of this part of *Mola* actually increases with the advance of age, we have here a remarkable instance of post-larval effort to regenerate a part which has degenerated and been absorbed during the larval period of existence, as we have already pointed out in another part of this paper. The figure of the caudal skeleton of *Molacanthus* in place shows that it is an exceedingly small part of the whole fish, while in the young of *Mola* it becomes wider, and in the adult still wider anteroposteriorly, while it has increased greatly in thickness and changed the form of its posterior contour. These are some of the facts upon which I rest my thesis that, *there actually occurs in Mola a secondary development of the tail, by which that organ is, so to speak, redeveloped from traces of epaxial and hypaxial tissues which had not been absorbed at the time the tip of the larval axis degenerated.* Taken altogether, the tail of *Mola* thus presents us with one of the most interesting chapters known to me in the whole range of vertebrate morphology, and it has been my real purpose to reconcile it with the general theory of the development of the caudal fin developed in this memoir, constituting as it does an extremely aberrant form, which had to be very thoroughly examined with that object in view, and

not, as I fear it may be supposed, merely to demolish the grounds upon which the *Molacanthidæ* have been recognized as a family.

A remarkable reduction in the number of caudal rays occurs in *Mola* during the period of growth intervening between the time when it is about two inches long and the time when it is full grown. In the young two inches long there appear to be about twenty-three caudal rays developed; in the adult, on the other hand, if Wellenbergh's figure is to be relied upon (Fig. 9, Pl. VIII)—and it is seemingly very accurate—there are only thirteen caudal rays. This elision or loss of rays seems to occur in the central part of the caudal, while those rays which are distinctly epaxial and hypaxial in position seem to be preserved. The tail-like process in the center of the tail-fin of the young, together with its six nearly simple filamentous rays, appears to be entirely absorbed and suppressed. To what extent the filaments represented by Putnam extend beyond the margin of the caudal of the young I am unable to say; but of this I am certain, that the epaxial and hypaxial caudal rays are not simple, as figured by Putnam, but are dichotomous and soft, having three to four terminal branches. The specimens which I have in my possession for study do not show the radial filaments or their divided ends exserted to anything like the extent represented by Putnam, and I am very much inclined to believe that the specimens which are before me are normal, and have never had any such naked projecting filaments.

It is certain, however, that the dichotomous character of the caudal rays of the young of *Mola* does not persist, but entirely disappears by about the time that they assume their final condition in the adult, and that what with their reduction in number to thirteen and the loss of their dichotomous character and the retreat of their apices from the extreme margin of the caudal fin, the fin, as a whole, undergoes even a tertiary metamorphosis in passing from the young form distinctly recognizable as *Mola* to the adult condition. We thus find that *Mola* presents the most extraordinary series of transformations in respect to the development of its caudal rays to be found anywhere amongst Teleost fishes, the origin of which we can explain only upon the ground that the abbreviation of the tail of the larva and the suppression of the primitive terminal somites of the body have been more extensive in this instance than in any other. Additional morphological and embryological proof of the position which I have taken will hardly be necessary, but it may be well to call attention to the fact that the remarkable arrangement of the muscles of this family of fishes is also unique, yet it is not impossible to explain even this modification according to the general theory of development, as will be seen in the sequel. When we remember that the vertical fins of *Mola* are moved by a series of powerful muscles, the substance of which comprises almost the whole of what corresponds to the lateral muscular masses of normal Teleosts, we must conclude that what is ordinarily developed in

other forms into segmentally arranged muscular somites, in this instance becomes subservient to producing the movements of the vertical fins. Upon dissecting a very large specimen we find that the somatic musculature is divided into bundles, which radiate for the most part in a backward, upward, and downward direction, and in a semicircular series to the dorsal, caudal, and anal, into the bases of the rays of which they are inserted by powerful tendons. There are two series of these bundles, with their tendinous terminations, one on the right, the other on the left side of the body, corresponding to the muscular masses of the right and left sides of normal fishes. The tendons are round and lustrous white, and pass through a mass of very tough, elastic tissue, almost cartilaginous, which extends along the bases of the vertical fins, long tubular openings being excavated in the basal cartilage-like substance, through which the long tendons glide. In this way a muscular apparatus is developed on the one side of the body which opposes that on the other, and which most effectively moves the high vertical fins from side to side; and the two series of muscles and tendons inserted into the caudal move it from side to side, very much like the rudder-chains of a ship move its rudder. There is also this resemblance between the caudal of *Mola* and a rudder, that the strip of compressible elastic tissue at either side of the base of the tail acts as a sort of hinge, upon which this thick, rigid, truly rudder-like organ swings from side to side. A slightly similar arrangement is found in *Ostracion*, but the modification is not carried to anything like this extraordinary degree of specialization.

Now, what is the meaning of this modification? Simply this, that almost the whole of the lateral muscular masses have been converted into bundles of muscles terminating in tendons, the function of which is to move the vertical and caudal fins. And how is this change from the normal condition to be explained on embryological grounds? If we examine the developing tails of normal Teleosts we find that the caudal musculature is developed from the last somites of the body; that in fact almost the whole of the muscular somites of *Mola* are used up in order to form the flexors of the caudal and vertical fins alone; whereas in normal Teleosts only a very few of the terminal muscular segments of the urosome are used up or transformed into the musculature of the tail and the vertical fins. This, I infer, may be regarded as the final proof that the tail of *Mola* has had a large part of its urosome aborted, as already urged, so that it was necessary to modify the more anterior series of muscular segments and subordinate them to the function of flexing the tail.

This metamorphosis of the myotomes of *Mola* into flexors of the fins is doubtless due to the fact that the skin of the animal, in large specimens, is quite half an inch thick, thus constituting an almost rigid covering over the body, which would either induce muscular degeneration or metamorphosis.

I do not see that it necessarily follows that the centrum of the seventeenth vertebra of *Mola* consists of two consolidated vertebral bodies, because it has three elements above and three below it, which Putnam, it seems to the writer, erroneously regards as neural and hæmal arches. They are evidently nothing but interspinous pieces, shoved into this strange position by the process of development already described. They apparently disappear as soon as the fish becomes adult. We are not told whether they are forked proximally, as neural and hæmal arches should be when in contact with so large a centrum. In the adult there is good reason to suspect that these "floating" interspinous elements referred to above have been co-ossified so as to form apparently a single element, if we may place full confidence in Wellenbergh's figure* of the adult skeleton. They seem in Putnam's figure of the skeleton of the young of *Mola* to be simple bars or rods, separated by an interval from the last "floating vertebra." It is much more probable that they are merely interspinous elements, like the remainder of the chain. They cannot, at any rate, be homologized with the epural and hypural processes of normal Teleosts, which consist, as we have shown elsewhere, of neural, hæmal, interneural, interhæmal and basilar interneural and basilar interhæmal elements.

Measurements of the height and length of the principal stages of growth are interesting, and show that the metamorphosis from *Ostracion boops* to *Mola* proceeds progressively, as shown by the gradual changes in the proportions of these two dimensions. The proportions of the length to height in *Ostracion boops*, measuring from between the anal and dorsal forwards and above the eye for the length, and for the height obliquely across the eye, are in—

Fig. 1, length to height as 1 to $1\frac{1}{2}$.
Fig. 2, *Molacanthus*, length to height as 1 to $1\frac{1}{2}$.
Fig. 3, *Molacanthus*, length to height as 1 to $1\frac{3}{7}$.
Fig. 4, *Mola*, length to height as $1\frac{2}{5}$ to 1.
Fig. 5, *Mola*, length to height as $1\frac{1}{2}$ to 1.

This will conclude the arguments which we have presented in favor of regarding *Molacanthus* as merely the young of *Mola*. What differences the corresponding stages of growth of such a form as *Ranzania* or *Masturus* might present in contrast with the known stages appertaining to *Mola*, it is impossible to say in the absence of sufficient material for comparison; but it is safe to assert that no amount of additional evidence will be at all likely to break down the reasons here given for the incorporation of *Molacanthus nummularis* (Walb.) Gill, with *Mola rotunda*, Cuv., as one and the same species, for the reason that it is perfectly safe to predict that when such additional evidence is forthcoming it will probably confirm the position which has been here assumed.

*Observ. Anatomicæ de Orthagorisco Mola. Diss. Inaug. P. H. J. Wellenbergh. Lugduni-Batavorum, MDCCCXL.

It now remains for me to suggest that the true larval condition of *Mola* should be sought for amongst the surface trawlings taken during marine explorations, and I will venture to say that when that larva is found it will very probably differ as much in general appearance from *Ostracion boops* as the latter differs from *Molacanthus* or *Mola*. It is very probably provided with some rudiment which represents the tail of normal fish larvæ. The eggs of *Mola* are very probably pelagic, the larvæ having the same habit.

X.—Discussion of the serial homology and the influence of heredity on the development of continuous fin-folds.

The *Ichthyopsida* or *Anamnia* constitute the lowest portion of the vertebrate phylum. In contradistinction to the more developed types, they possess, almost without exception, at some stage or other, an eradiate dorsal and ventral fold of epiblast, which serves as an organ of propulsion through the medium in which they usually live, either temporarily or permanently. This is characteristic of the group, from *Branchiostoma* to the highest Batrachians, and all the exceptions which are known amongst existing forms are readily explicable on the ground that these have specialized modes of development, which either abbreviate the latter process or induce precocious degeneration of this particular structure. The entire piscine series possess in some form or other this mesial propelling organ, supported in the adult by simple or dichotomous segmented osseous, or by cartilaginous rays, or by fibers. In contrast to this series the median fins are more or less transitory or larval in the Amphibian series, and unprovided with rigid axial supporting organs.

The only Vertebrate which still retains a more primitive system of locomotive organs than the median system of fin-folds, characteristic of the larvæ of the rest of the *Ichthyopsida*, is *Branchiostoma* while it is still in the archicercal or vermiform stage, when most of its epidermis is still clothed with vibratory appendages or cilia.

The lophocercal eradiate stage of development of the azygous epiblastic—really epidermic—fold on the dorsal and ventral aspects of the body seems, therefore, to be eminently characteristic of most fish-like forms during an early stage of their growth. The multiradiate diphycercal condition, which replaces it by a process of natural evolution in *Ceratodus* and *Protopterus*, is primitive, and permanently approached and represented only by the numerous distal branches into which the rays of many Teleosts subdivide at their tips, where traces of the distinct primitive fibers or horny filaments are often clearly marked, even in the most specialized forms, such as *Scomber* and *Xiphias*, or the Mackerel and Sword-fish, along the margin of the caudal fin.

Ceratodus and *Protopterus* are examples of an imperfect embodiment of the protopterygian stage. In these some of the primitive horny fibers or fin-rays have fused together to the number of as many as three,

usually not over two; in other fishes many of these fibers become involved to form a single ray. *Chimæra* and its allies are also very primitive, their fin-rays attaining but a slight advance in development beyond what I have denominated the Protopterygian stage of the embryos of Teleosts; yet even in *Chimæra* the rays are not absolutely simple, as in the embryonic condition, traces of their coalescence being present. And I would here insist that the material of which the primitive fibers consists in all fishes, be they Elasmobranchs, Dipnoans, Ganoids, Chimæroids, or Teleosts, is similar in its nature and origin and its relations to the primary embryonic layers; that the point where the fin-rays join or overlap their cartilaginous supports in the embryo is homologous throughout the entire phylum of the fishes, and constitutes, for the pectorals and ventrals at least, a starting point of equal value with the articulation of the proximal elements of the limb to the shoulder or pelvic girdle, for the purpose of determining the homologies of the bones or cartilages which form the true axial skeleton of the limbs.

Dr. Günther, in his valuable monograph on *Ceratodus** (p. 530), says: "The dermo-neurals of *Ceratodus* are not articulated to the extremities of the interneurals, but overlap them for a considerable distance of their length. The shape and arrangement of the dermo-hæmals is exactly the same as that of the dermo-neurals. No ossification takes place in either of them; they consist entirely of cartilage, in which numerous spindle-shaped cells are imbedded, many of these cells being produced at both ends into a very long process (Pl. XXXVI, Fig. 7)." These dermo-neural and hæmal elements, as Dr. Günther calls them, are the exact homologues of the horny fibers of fish embryos, and cannot, I regret to say, be regarded as cartilaginous either in origin or histological character. They are allied in constitution to the material in which the ossification of membrane bone occurs.

Dr. Günther also remarks of the fin-rays of *Ceratodus*: "They are exceedingly numerous, four or five or more corresponding to a single vertebral segment, and form a double series, one series on each side of the fin. This peculiarity, which *Ceratodus* has in common with *Lepidosiren*, reminds us of those fin-rays of Teleosteous fishes which can be more or less completely split into a right and left half."

This quotation becomes remarkably significant in the light of the facts of development, since we now know that the right and left halves of the rays of Teleosts actually develop in part from the double series of embryonic fin-rays which underlie in a single layer the right and left dermal wall of the fin-fold. The large number of fin-rays to a single segment in *Ceratodus* likewise no longer appears strange; this condition being simply indicative of the fact that the specialization and the fusion of the embryonic fin-rays into powerful rays has not gone so far as in the more developed and specialized Teleosts, which have all the

*Philos. Transactions, Pt. II, 1871, pp. 511-571.

other parts of the skeleton well ossified. The embryonic condition of the fin rays of *Ceratodus* is in perfect keeping with the development of the rest of the animal's skeleton, which is very largely cartilaginous, so that in a general way it closely resembles in the degree of its development that transitory stage of the Salmon embryo when the embryonic rays are still distinct and parallel with each other. To find such a parallelism existing between an embryo Teleost and the adult of *Dipnoi* is, to say the least, very suggestive of the thought that the Teleostean and Dipnoan phyla are remotely affiliated. On no other ground are we enabled to understand why it is that a Teleost should recapitulate so closely in the course of its development conditions which are permanent in the *Dipnoi*.

Protopterus resembles *Ceratodus*, according to Wiedersheim,* in the structure of its median fin-system, and presents the same dorso-ventral symmetry of the upper as contrasted with the lower half of the tail. The main difference which these forms present when compared with the lophocercal condition of the caudal end of the body of fish larvæ is the presence of partly osseous neural and hæmal spines, interneural, interhæmal, and basilar interneural and basilar interhæmal elements, which support numerous rays nearly equivalent to the embryonic fin-rays.

The tail of the Crossopterygian *Polypterus* exhibits a tendency to become heterocercal, hardly, however in proportion to the extent to which ossification has proceeded throughout the entire column. The persistency of the axial symmetry of the caudal fin we must therefore regard not necessarily as symbolical of its degeneracy or completed evolution, but rather of the persistence of conditions which have not disturbed that symmetry. That the condition of dorso ventral symmetry found to obtain at the posterior part of the chordal axis of fish embryos generally is the most ancient is conclusively shown by the evidence derived from all known types of fish-larvæ.

As already indicated by competent observers, the lophocercal condition precedes the heterocercal, which is itself followed by the outwardly homocercal condition; yet there are instances known in which this rule is violated to some extent, as I have already pointed out elsewhere. These are where (1) the median fins are not developed from a continuous median fold, as in *Siphostoma*, *Hippocampus*, and *Gambusia;* and (2) where a truly lophocercal homocercy precedes the structurally heterocercal stage of development, as in *Alosa*, for example. In both of these instances, however, there is no reason to believe that we have any embryological principles contradicted, but that in reality those principles are confirmed by these apparent exceptions.

It is therefore noteworthy that the primitive embryonic rays in the tail of the embryo of *Alosa* have a perfectly symmetrical disposition above and below the caudal axis, as shown in the dotted lines in Fig. 2, Pl. II.

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* Vergleichenden Anatomie der Wirbelthiere, Jena, 1883 and 1884.

This proves conclusively that the diphycercal condition so perfectly preserved in *Ceratodus* is actually recapitulated by the larvæ of existing forms, since the primitive embryonic rays undoubtedly represent almost exactly the permanent rays of that form.

Taking the examples of *Siphostoma* and *Hippocampus*, both are highly specialized types of Teleosts; in the former a dorsal, anal, and caudal are developed directly in special discontinuous folds in the situations where they are permanent, though an abnormal specimen shown me by Dr. T. H. Bean has a small second anal developed in an intermediate situation, where it is readily conceivable that it was derived from a part of the continuous tract which in other fish embryos gives rise to all of the median fins. This specimen must, therefore, be regarded as an example in which there has been a very imperfectly successful attempt at reversion towards the most ancient and primitive condition of the caudal skeleton, which is permanent in *Ceratodus* and *Protopterus*. The tail of *Siphostoma* is, however, developed in much the same way as in other forms, though the *dorsal lobe*, or tip of the lophocercal condition of the tail is very feebly marked.

Hippocampus, unlike the last-named genus, has passed through a still more extreme series of modifications, and in consequence not only develops its median fins in separate or discontinuous folds, but the tail, in consequence of the acquisition of a prehensile function, has also almost lost all trace of a median caudal fold, this fin altogether failing to develop at any subsequent stage, Fig. 3, Pl. IV. With other types this form contrasts in the most remarkable way, since it is the only form in which the cartilaginous axis of the body is bent and coiled upon itself ventrally, or in a direction just the reverse of the usual one in the larvæ of fishes. From the remarkable manner in which this fish swims, with the body in a nearly erect position, and the use of the tail as a grasping organ, it is fair to assume that this part of the animal has suffered degeneration as far as the absence of a caudal fin is concerned, and specialization, in consequence of its development into a grasping organ, which has involved the modification of the caudal muscular somites into special flexor muscles having a ventral position.

In *Gambusia* the failure to develop a continuous median fold is rather remarkable. It is possible, in consequence of its viviparous development, that the development of the median fins has been abbreviated and followed a more direct path, as just noticed in the *Lophobranchii*. Since the young of *Gambusia* are developed within the body of the parent female till they are nearly like the adult in form, it may be that the usual method of development of the fins has given place to a much more direct one, influenced possibly by inclosure within the ovary of the parent, as a result of which hereditary influences would be intensified. At any rate, it is certain that the condition of development reached at the time of the first appearance of the median fins as separate folds is no more advanced in other respects than in an embryo Salmon or Shad, in which there is a continuous median fin-fold still present.

In *Alosa* the median fin-fold is continuous and high, and at an early period there is a slight vertical expansion of the caudal portion of the median fold, which is the prelude to a fan-shaped condition, which is attained while the caudal is still eradiate and the chorda is straight at its hinder extremity. In this condition the tail is outwardly homocercal, but really lophocercal, because it is still without any other than faintly developed embryonic rays. In this form there is no outgrowth of a distinct ventral lobe, but, on the contrary, the tail of the adult is developed directly from this symmetrical larval tail, the mesoblast of the tail wandering outward directly into the caudal fold, where it is transformed into the substance of the hæmal pieces and medullary substance of the rays. This in like manner is an example of abbreviated development, though it occurs in a Physostomous form, which is manifestly more primitive, because it possesses a perforate pneumatic duct, than those Physoclistous forms which pass through that stage of development of the tail which is permanent in the fishes of the Devonian age.

The causes of the failure to develop a stage in *Siphostoma* and *Hippocampus* with a continuous median fold, such as is found in other forms, are readily explicable on the ground that they are extreme modifications of the ordinary Teleostean type, but when we consider the two cases of *Alosa* and *Gambusia* amongst the Physostomes, with the modifications of development which the one presents in respect to all of the median fins, and the other in respect to that of the caudal, we are bound to admit that they present singular and striking exceptions to the rules governing the development of the tails of fishes first laid down by L. Agassiz and C. Vogt. Fortunately these exceptions are very few, and they therefore do not affect the general principle upon which these authors insisted as much as might be supposed upon first thought, because after all, in the most important exception, *Alosa*, the tail finally becomes heterocercal in structure just as in almost all other Teleosts, the symmetry of the caudal of the larvæ being simply an acceleration of the process which ordinarily occurs, together with an apparent elision of some of the stages which usually accompany the transformation of the lophocercal tail of the larva into the homocercal or heterocercal of the adult, as the case may be.

The writer has elsewhere expressed his views in relation to the continuity or discontinuity of the median and paired fins, and has suggested the probable reasons for the existence of such differences between embryos of a similar age, in the following words: "*Hippocampus* never develops a caudal fin, so that we would naturally not expect to find the natatory fold prolonged over the end of the tail; but the posterior position of the early rudiments of the pectorals in *Cybium* and *Parephippus*, it appears to me, is a very strong argument against their origin from a posterior branchial arch (a conclusion since reached by Dohrn); indeed, it is the strongest yet offered against that doctrine by

any data derived from a study of the development of the paired fins of Teleosts. In other words, since we now know that the natatory fold, from which the unpaired median fins are developed, is sometimes discontinuous, I see no reason why we should not expect to find the lateral fin-folds discontinuous, as there are more reasons why they should be so in the Teleost than in the Elasmobranch embryo. In fact, it would appear that the greater the longitudinal extent of the unpaired fins, in proportion to the length of the body of the adult, the more likelihood there is of finding a continuous dorsal and ventral natatory fold developed in the larva, and *vice versa*. The longitudinal extent of the paired fins of Teleost fishes is less, vastly less, in respect to the number of supporting rays than those of the Elasmobranchs, and in consequence of this difference alone we should not be surprised to find lateral fin-folds of considerable extent in the former. Viewed in this way, we may prove too much for the doctrine of the origin of the paired fins from lateral folds."*

The principle stated by Balfour in the following words, "*the limbs are the remnants of continuous lateral fins*,"† may possibly need qualification, if the preceding view is justified. The case of the embryo *Torpedo*, in which the continuous lateral folds are especially well developed, does not seem to me to be conclusive for the reasons urged above, because that form and its allies *Narcine*, *Hypnos*, &c., have developed in the adult condition what has been denominated a cephalic fin. It thus turns out that we here have the influence of the principle verified which is palpably operative in the case of the embryos of Gadus and the Flounders. Both of these having the median fins of the adult approximated, the tendency would naturally be toward the development of a continuous median fin-fold in their larvæ, such as we find to be actually the case. It thus becomes evident that heredity may directly affect the mode of development of the young. The opposite condition of discontinuity in the *Lophobranchii* is similarly explicable.

Whether the cephalic fins of *Torpedo* were primitively a part of the pectoral or not, as Gegenbaur would urge, is immaterial, for the great extent of the lateral fin-system in the adult must obviously affect the development of the early rudiments of the limbs in the embryo, and tend to cause their first appearance as uninterrupted folds.

In the adult *Torpedo* the cephalic fin does not possess all the traits of a paired fin with straight, parallel cartilaginous supports (see Gegenbaur, Das Kopfskelet der Selachier). In *Hypnos subniger*, on the other hand, the supporting rays of the cephalic fin, according to Haswell,‡ are present as nearly parallel bars, resting in part on a pair of anterior

* Development of the Spanish mackerel (*Cybium maculatum*). Bull. U. S. Fish Commission, I, 1881, pp. 160, 161.

† Monog. on the Develop. of Elamosbranch Fishes, p. 102.

‡ Studies on the Elasmobranch skeleton. Proc. Linn. Soc., of New South Wales, Vol. IX, 1884, pp. 105, 107, and 116.

divergent basal bars, supported by the antorbital cartilages, partly on the sides and ends of the cranial rostrum. By what process these bars came to assume such a relation to the chondro-cranium of *Torpedo* is not clear, unless we assume, as supposed by Gegenbaur, that a part of the anterior end of the propterygium became detached from the pectoral and was secondarily affixed to the antorbital process of the skull. This is an explanation, but is it the one which will be finally accepted? This may be doubted, for even supposing that this view is the true one, it is rather singular that the cartilaginous rostrum in *Hypnos* should divide into three lobes, each supporting rays, while on either side of it accessory rays should be found. What seems to be the difficulty is this: Why must it be supposed that the rostral rays are not directly developed in the connection in which they are found? An answer to this question can scarcely be expected until the development of the cephalic fin of *Torpedo* or one of its allies has been actually traced.

The peculiarities of development of greatly specialized forms evidently do not furnish safe criteria upon which to base general conclusions in respect to the development of all affiliated forms, as the preceding cases would seem to indicate. As another instance of this may be cited the fact that the single vertebral centra of *Lophobranchii* support a number of neural arches, which in certain regions are certainly first laid down in cartilage. The usual rule is a single neural arch to a single centrum, though in the tail of *Amia* this rule is violated in another way, only alternate centra supporting arches in this case. In Elasmobranchs still another arrangement of arches and centra obtains.

In *Siphostoma* it is stated by McMurrich that a distinct fibrillation takes place in the fin-folds of the embryos, "which, increasing, leads to the formation of horny rays."* A similar remark applies to the development of the rays of *Hippocampus* in the pectoral, anal, and dorsal fins. McMurrich's statement, however, that the anal of *Siphostoma* aborts after developing embryonic rays, must be denied, since the anal is present in adults of both sexes of specimens of the same species which have been examined by the writer. The interspinous cartilages are also much more complex in the embryo of *Hippocampus* than in *Siphostoma* of nearly the same age as those figured by McMurrich. The erectores and depressores spinæ muscles terminate as tendons which are as long as the elements which I have elsewhere called *basiradial cartilages*.† These basiradial elements are cartilaginous, and each one at its distal end supports a small cartilaginous nodule or actinophore, which is the representative of a basilar interneural piece. Consequently the cartilaginous bars, the whole of which McMurrich calls interspinous, are only

* On the Osteology and Development of Syngnathus peckianus (Storer). Quar. Journ. Mic. Sci., XXIII, pp. 623–650, 1883.

† A contribution to the development and morphology of the Lophobranchiates (*Hippocampus antiquorum*, the sea-horse). Bull. U. S. Fish Com., I, 1881, pp. 191–199. 1 plate.

partially homologous with the interspinous bones of normal forms, for at the proximal ends of the basiradial cartilages there is a constriction at the point where they are continuous with the neural spines proper, which become suddenly larger proximad of the constriction. Moreover, these bars bifurcate at the proximal ends, the bifurcation passing over either side of the spinal cord, and the ends finally rest on the upper aspect of the chorda, thus constituting the true neural arches, of which there are evidently several to a single centrum. We therefore have in the young sea-horse neural arches, interspinous and basilar interneural elements represented in cartilage as the supports of the dorsal, which are in no sense to be regarded as "rays," but as epaxial vertebral arches and their distal appendages. The interspinous portions of the extremities of the successive arches are fused together, as observed by McMurrich in *Siphostoma* of a similar age, but just proximal to the basilar interneural cartilaginous nodules or actinophores there is a general flattening of the cartilage cells and a tendency to indicate that an articulation is in process of formation between the interneural and median actinophoral elements.

The structure of the distal part of the anal of the young of *Hippocampus* is exactly similar to that of the dorsal.

It is interesting to note, also, that the neural arches in both *Hippocampus* and *Siphostoma* correspond in number with the rays, which in other forms are often in excess, together with their homonymous interneural pieces, of the number of homonomous neural spines. Here the neural spines are in excess of the number of vertebral centra by about five to each centrum, only about three centra underlying the dorsal of *Hippocampus*. In *Siphostoma*, on the other hand, nine vertebral centra afford arches to support the rays of the dorsal, which number about thirty-five, or an average of about four rays to each centrum. Each vertebral centrum of these Lophobranchiate genera therefore develops a number of distinct neural arches. Their number seems to be about five to six to each centrum. The vertebræ of these types may therefore be said to be *penta-* and *hexacanthous* dorsally.

Proximally these arches, in *Hippocampus* and *Siphostoma*, tend to concresce or be drawn closer together in an antero-posterior direction. In the first genus all of the neural arches are thus drawn together proximally, the effect of this concrescence being most visible in the oppositely inclined position of the anterior and posterior neural elements, respectively. It follows from this that we may possibly be justified in assuming that the dorsal at one time, in some ancestral form of *Hippocampus*, was supported by more centra than at present. In *Siphostoma* this tendency toward proximal concrescence is manifested by the group of neural arches belonging to single centra of the series which afford the dorsal fin its support.

The fin-rays of both these forms probably originate in mesoblast, as I have shown to be the case in *Salmo*. What lends additional proba-

bility to this interpretation is the circumstance that the tendons of the muscles which move the rays are attached, not to the "nodules" or basilar interneural cartilages, as stated by McMurrich, but to the membrane of the bases of the rays enveloping these nodules. Such a continuity of muscular and tendinous substance with the membrane of the rays, in which ossification subsequently occurs, obviously points to the conclusion that all of these tissues arose from the same primitive blastema, *i. e.*, the mesoblast.

Balfour and Parker* have recently asserted that in the ventral limb of the caudal of *Lepidosteus* there are no interhæmal pieces developed, as there are in the dorsal side of the urostyle, and that the rays which lie below the caudal axis lie against hæmal pieces. They therefore urge that the caudal is not serially homologous with the anal or the dorsal. They also urge that in *Anguilla*, according to Huxley, while outwardly there is an apparent serial homology of the dorsal and anal rays over the end of the tail, such is not really the case, but that structurally the tip of the tail is truly hetorocercal, some rays resting directly upon hæmal pieces. In *Polypterus* this is the case, as well as in most homocercal Teleosts, though it is, perhaps, unfair to urge this argument to extremes, for, while the dorsal part of the caudal in *Polypterus* and some Teleosts is undoubtedly serially homologous with the dorsal, there are cases among *Nematognathi* and Scomberoids where the interneural pieces in this part of the caudal fin are suppressed, or so reduced and co-ossified as to be obscured.

Not only is this true, but there is also a certain amount of evidence to show that some traces of interhæmal pieces or their representatives are present in the tails of Salmonoids as interspinous cartilages, or as small nodules of cartilage at the tips of the hæmal spines; that with the advance of specialization suppression of certain elements is not only probable, but is also, as we have seen above, supported by the facts of the probable presence of rudiments of interhæmal elements. Interhæmal elements are probably developed about cartilage in most Teleostean forms, certainly in some, and in a few forms they never develop much beyond a cartilaginous condition, as in *Gastrostomus*, for example. Why interhæmal or interneural pieces should apparently not be present in the caudal is not any more difficult to understand than that the basipterygium is reduced, and the rays more nearly sessile in the Teleosts than in most of the other members of the piscine series. In *Gastrostomus*, for example, a specialization of the pectoral has been reached, as a consequence of which the rays are sessile upon the coraco-scapular plate of cartilage, so that a condition is here preserved which is transitory in fish larvæ. In all these cases suppression of the intermediary pieces has evidently occurred as general specialization has proceeded. If we regard *Ceratodus* as exhibiting the most primitive type of caudal; if it has not, in fact, been affected by a general tendency to exhibit a

* On the development of Lepidosteus. Philos. Trans., 359–442, 1882, pls. 21–29.

biserial repetition of parts correlatively, such as is apparent in the pectoral and ventral fins, then I think it is fair to regard this as the oldest, most unmodified, and nearest the condition of an archetypal caudal from which all the other modifications of the tail fin have been derived by descent with modification.

The Dipnoan *Ceratodus*, with its powerful pectoral and ventral limbs, which exhibit such a singular biserial and segmented arrangement of the elements of the limbs—even the muscles partaking of the last character, so that they are in part segmented, according to Davidoff, in a manner somewhat similar to the myotomes of the body—have had a powerful influence in retarding the modification of the tail; for in no Teleosts, with the exception, perhaps, of the *Pediculati*, do the muscles of the appendicular skeleton extend so far outwards as to form a pedunculate limb. In *Ceratodus*, however, we must not be too hasty in concluding that the segmented musculature of the paired fins is correlated with the segmented musculature or myotomes of the tail or urosome. Since we know that metamerism begins to be developed from within outward in the body, if we examine this condition as to its origin in the limbs of *Ceratodus*, we will reach a similar conclusion. Embryology has proved that both the muscular and skeletal tissues of the limbs are at first unsegmented; from the mode of differentiation of the muscular buds thrust into the limb folds from the primitive somites (gut-pouches), we may get an inkling of how the segmental arrangement of the flexor and extensor muscles of the limbs of *Ceratodus* arose. Our view is necessarily only tentative, because the development of the form is not known, but it is certainly not venturing too much upon hypothetical ground to suppose that the mode of outgrowth and concrescence of the muscular buds of the somites which entered into the formation of the musculature of the limbs gave rise to the segmentation of the axial cartilage of the limb, which, as in other forms, must have been a continuum at an early stage, just as the chorda remains unsegmented so long as no osseous or distinctly chondrified tissues invade or replace it, so as to make it rigid, and thus give rise to the necessity for the existence of segments or vertebral centra, in order to make the axis of the body flexible and under the control of the forces exerted by the muscles.

XI.—The tendency of heterocercy towards gephyrocercy.

The general principle that the changes wrought by organic evolution are progressively developed, is illustrated in the most forcible way by the morphological history of the caudal fin of fishes. In the tail of *Mola* we have the extremest expression of gephyrocercy, while at the opposite extreme of undifferentiated, primordial, embryonic caudal development we must place the Dipnoans, Marsipobranchs, and Leptocardians. Taking a glance at our figures, we may readily verify the fact that heterocercy seems to be tending towards gephyrocercy as the final term of caudal differentiation.

On Pl. I, Fig. 1, the archicercal filament of *Chimæra monstrosa* shows that there is a tendency in one of the lowest types to abort the end of the caudal axis and develop the true caudal farther forward. Turning now to a representative of the *Teleostei* the same thing is repeated in *Gastrostomus Bairdii*, in which the tail is actually lophocercal at the tip in a specimen one-third grown, and with no epaxial or hypaxial rays developed for a considerable distance in advance of its termination. This last type is, however, archaic in some respects. Turning now to *Polypterus* (Pl. V, Fig. 2), the chorda is exserted posteriorly, and does not support neural or hæmal arches for some distance behind the point where the development of vertebral bodies is discontinued. The tail is roundly fan-shaped; some proximal concrescence of the hypurals is evident. The young of *Lepidosteus* (Fig. 6, Pl. V) shows that the termination of the chorda does not develop inferior and superior arches. Yet the embryonic rays are developed in the fin-fold posterior to the last arches. In the next stage the opisthure (Fig. 5, *op.*, Pl. V) is fully developed, the evidence of degeneration which it affords being complete. In Fig. 3, Pl. V, of the adult tail, the end of the unabsorbed remnant of the still more degenerate urochord extends into the dorsal portion of the caudal fin. Concrescence or crowding together of the proximal ends of the supports of the rays is evident. In *Platysomus* (Fig. 4, Pl. V) the end of the chorda is more massive, more persistent, with a less marked proximal crowding of the bases of the rays, contrasting strongly in this respect with the primitive caudal skeletons of *Coccosteus*, Fig. 1, and *Centrina*, Fig. 8.

Turning now to the contemplation of the changes which go on during development, as shown on Plate I, the evolution of the heterocercy of the Flounder's tail displayed in Figs. 3 to 10, after Agassiz, shows that the crowding from behind forward of the proximal ends of the epaxial and hypaxial pieces keeps pace with the gradually increasing heterocercy. On Plate III, illustrating the formation of the caudal skeleton of the Salmon, the same thing is again shown, actual concrescence or blending of two hypaxial elements being in progress in Fig. 4.

In the caudal skeleton of adult Teleosts, that of *Barbus* (Pl. VI, Fig. 3) illustrates the proximal crowding referred to. In *Salmo fario* (Fig. 1, same plate) and in *S. salar*, this is illustrated again, but the urochord or urostyle is not so extensively exserted as in Fig. 3. *Salmo salar* also has the end of the chorda more sharply bent upward, and the crowding proximally of the hypural pieces is more pronounced. The hinder epural pieces, *ep′ ep′*, are slid backwards somewhat in consequence of the markedly upbent urostyle, so that if the latter were now aborted a structurally gephyrocercal tail would result, because the epaxial and hypaxial elements would then form a confluent series. In the caudal skeleton of *Cottus* (Fig. 1, Pl. VII) a more specialized type of heterocercy is shown, in which, as in *Gasterosteus*, *Anguilla*, and *Fistularia*, the number of hypaxial processes are reduced. The urostyle in these is almost sup-

pressed, but enough of it still remains to compel us to regard this type of tail as still truly heterocercal. In *Perca* (Fig. 2, Pl. VII) we have a stage intermediate between *Salmo* and *Cottus*.

The next phase in the evolution of gephyrocercy is that shown in Fig. 4, Pl. VIII, in *Fierasfer acus*,* where the process has been a direct one without a previous tendency to the development of heterocercy. The straight, probably partly archicercal, caudal filament is absorbed or lost in some way and the blunt end of the chorda abuts abruptly against the integument at the tip of the tail. The rays are not developed all the way round over the end of the caudal axis, so that there is an actual hiatus, *h*, between the last epaxial and hypaxial fin-rays. In *Echiodon*, gephyrocercy is more pronounced, as shown in Fig. 3, Pl. VII, because the last epaxial and the last hypaxial rays have been swung round so as to be nearly in contact and parallel, the abruptly terminated vertebral column being included so as not to come into contact posteriorly with the integument. This mode of the development of gephyrocercy was not preceded by the evolution of heterocercy, but it is nevertheless easy to see that in those heterocercal forms where the urostyle tends to be aborted or where it is greatly bent upwards it would need little more than the degeneration of the latter to produce the same ora similar result.

The Eel, while it has a structurally heterocercal tail in the adult, in the young (Fig. 4, Pl. IV) the caudal skeleton presents more nearly its embryonic condition, and it is noteworthy that the urostyle is so shortened and reduced as to be practically included by the surrounding parts, so that the last epural interspinous piece and the last hypural process become approximated much more perfectly than in any of the heterocercal forms hitherto discussed, and a near approach is thus made to a truly gephyrocercal caudal fin. Moreover, the last two interspinous bones if slightly prolonged forward would rest with their proximal ends upon the posterior face of the neural spine of the antepenultimate vertebra, thus simulating the arrangement found in *Mola*.

While *Amiurus* exhibits certain primitive traits, such as the possession of an adipose dorsal and a pneumatic duct, the tail is highly differentiated and strongly heterocercal. The hypural cartilages, however, show evidence of proximal concrescence, while at least six epural arches or spines have been lost; nevertheless, the tendency towards gephyrocercy is undisguised, and the opisthural element *op* in Fig. 1, Pl. IV, shows that the ancestry of *Amiurus* during a remotely bygone period possessed more hypaxial bones than the existing species. This

* Dr. Gill kindly called my attention to this type of tail, which resembles that observed by us jointly in *Labichthys*, a new genus of Nemichthyoid eels. Something of the same sort is said to occur occasionally in *Macrurus*, but Dr. Bean thinks that its development in this instance is due to injury or accidental loss of the lash-like end of the tail, because this mode of development of the caudal extremity is not constant in the same species of this genus.

opithural piece has apparently been left behind, as the chorda has bent upwards, and the seven hypural cartilages have been carried with it, their proximal ends having been at the same time crowded forwards, so that seven of them correspond to but three indistinctly marked segments of the urostyle.

The total suppression of the caudal rays of *Hippocampus*, as shown in the figure of the tail of its larva in Fig. 3, Pl. IV, is due to the new function acquired by the tail as a prehensile organ. How marked the influence of the atrophy of a part in the adult may be in determining its failure to develop in the young may be gathered from Fig. 2, Pl. II, of the tail of an embryo of *Alosa*. Here traces of five hypural cartilages have shown themselves, while in front and behind them none have yet appeared. On the upper side of the chorda no epurals have appeared, even in relation to the same segments which bear the rudiments of hypural cartilages, but the archaic gephyrocercal condition is clearly expressed even here, for we may note that the embryonic rays are continued round the end of the chorda as a confluent series. This condition we may denominate *protopterygian gephyrocercy.*

Turning now to the form in which gephyrocercy has been expressed in the most pronounced way, we need not do more here than call attention to the development which it attains in *Mola*, as shown on Plate VIII, which illustrates how the hiatus between the dorsal and anal seems to be filled up by a new outgrowth of rays, as indicated by the stages covered by Figs. 1 to 5, while a no less remarkable metamorphosis occurs in the passage from the condition shown in Fig. 5 to that of Fig. 9, or that of the adult. No evidence of the existence of heterocercy at any stage of the development of *Mola* is in existence, unless we may infer that its Plectognath ancestry was heterocercal. Gephyrocercy, here as in *Echiodon*, was directly developed, if we may legitimately infer that Fig. 1 is really the young of this or a closely allied form.

The constant tendency in the evolution of the caudal skeleton of fishes has been to either indirectly or directly abort the termination of the chorda or axial skeleton, and in the first instance to develop an upbent urochord, as in Elasmobranchs, with epural and hypural pieces resting on the whole of its upper and under faces; this same urostyle in higher forms became more and more shortened, reduced, and included by adjacent structures; while, in the last instance, the hinder terminus of the chordal or vertebral axis is wholly suppressed either in a very early larval stage (*Mola*), or persists for a longer or shorter postlarval period, as in *Echiodon* and *Fierasfer*. The tendency of all of these processes, however, is to bring about an approach towards a confluent series of epural and hypural arches or spines. The development of heterocercy always tends also to suppress the last epaxial arches, as in *Amiurus* and *Salmo*, so that if gephyrocercy were in these cases developed by an absorption of the urostyle, the supports of the caudal fin-rays and the rays themselves would be hypaxial in their morphological relation to the caudal axis.

XII.—ON THE INFLUENCE OF MUSCULAR METAMERISM ON THE DEVELOPMENT OF THE AXIAL AND APPENDICULAR SKELETON OF FISHES.

Herbert Spencer,* in a discussion of the origin of the form of the vertebrate skeleton, has, largely upon *a priori* grounds, attempted to account for the origin of vertebral segments. The hypotheses which he put forward were in the main justified by the facts then known, but are not quite in accord with the ontogenetic evidence since worked out by a number of embryologists. He says (p. 201): "It follows from the mechanical hypothesis that as the muscular segmentation must begin externally and progress inwards, so, too, must the vertebral segmentation." In defense of this view he instances the fact that the development of the truly osseous skeleton is centripetal, or from without inwards, the peripheral parts ossifying first. He supposes, in fact, that vertebral segmentation is entirely due to the flexures of the body produced by the contractions of the lateral muscles of fish-like forms during their movements through the water.

Such an hypothesis cannot now be unqualifiedly accepted, since the tendency amongst embryologists at the present time is to conclude that the muscular segments are derived from a centrally-placed archenteron, from which their rudiments grow out as hollow diverticula.† The effect of such a view, founded upon observed facts, as in the case of *Amphioxus*,‡ upon the hypotheses suggested by Spencer, it will be readily seen, is important, though it may be positively affirmed that while considerable modification seems necessary, the essential elements of the great principle of the mechanical genesis of vertebral segments suggested by the English philosopher remain true. The embryologists show, in fact, that the evolution of the muscular system proceeds from within outwards in the vertebrate embryo, instead of from without inwards, as is assumed by Spencer, though this does not impair the efficiency of the lateral musculature and what other muscles are derived from it in the fins in producing segmentation of axially-placed skeletal structures consisting of cartilage, bone, and membrane.

Sections cutting through the axis of a young Vertebrate, such as that of the Catfish, for example, show that the fibrous septa between the muscular segments end internally at the point where two successive vertebræ articulate with each other. The points where the muscular fibers begin and end therefore coincide with the points where segmentation of the skeletogenous tract, from which the vertebræ are developed,

* Principles of Biology, II, Chap. XV, pp. 192–209.

† *Cf.* Adam Sedgwick, On the origin of metameric segmentation and some other morphological questions. Studies from the Morphological Laboratory of the University of Cambridge, II, Pt. 1, pp. 77–116. Also O. Hertwig, Die Cœlomtheorie, Jena, 1881.

‡ *Cf.* Studien über Entwickelung des Amphioxus, von B. Hatschek. Arb. aus dem zool. Inst. d. Universität Wien, 1882.

will occur, and where alternate compression and extension or even sundering of the continuous axial, skeletogenous, tubular membrane must occur, owing to the simultaneous contraction of an extensive series of successive muscular segments, entailing a pronounced bending of the whole body. In some such manner we are, it seems to the writer, bound to infer that the segmentation of the axial skeleton of the vertebrate body was initiated, for the reason that the segmentation of the muscular precedes that of the skeletal system—nay, that the mesoblastic myogenous layer of tissue from which the muscular segments develop is subdivided into segments even before it can be said that there is otherwise the slightest evidence that their component cells will become muscular fibers.

These facts seem to me to strongly re-enforce the conclusions of Hertwig and Sedgwick that the origin of the structures which led to the development of vertebral metamerism may be traced as far back as a little above the gastrula, and it may even not be too bold a procedure to assume that the lateral gut-pouches, whence the muscular segments of Vertebrates are probably always developed, have been derived in the course of the progress of evolution from the folded enteric walls of a diploblastic or two-layered cœlenterate ancestry, as held by the latter and Dr. E. B. Wilson,* now that structural bilaterality may be predicated of many *Actinozoa*, as is distinctly shown by the investigations of these authors and Milne Marshall. If such is the true explanation of the origin of vertebral metamerism, as it seems we have many weighty reasons for believing, it is only a step beyond this to apply the doctrine to the whole of the fin and limb skeleton of fishes—an expansion which it has already practically attained through the ontogenetic researches of Anton Dohrn upon the Elasmobranchs, already alluded to elsewhere, though the relation of the anterior muscular somites to the pectoral limb in Salmonoids amongst Teleosts was first indicated by another author.†

Examining longitudinal vertical sections of embryo Teleosts, the observer is struck by the fact that the vertebral spines and interspinous elements of the vertical fins originate almost exactly in the intermuscular septa which separate the muscular segments, while the muscles which move the fins are quite as clearly derived from the upper and lower extremities of the successive muscular segments corresponding in position with the successive interspinous intervals. In the Elasmobranch embryo the correspondence between the successive muscular somites and the diverticula of their upper ends, which they push upwards on either side over the spinal canal into the base of the dorsal fin, is even more clearly marked in sections of embryo Dog-fishes than

*The mesenterial filaments of the Alcyonaria. Mitth. aus d. zool. Sta. zu Neapel, V, 1. Hft., pp. 1–27, 1884.

†Jos. Oellacher: Entwickelung einiger Organe der Forelle. Ber. d. nat.-med. Ver., Innsbruck, 1878, p. 141.

in the Teleosts, showing that the muscular metamerism at the base of the dorsal is directly dependent upon the metamerism which is observed in the lateral muscular system, which, as we have already noticed, has determined the metameric arrangement of the interspinous or intermuscular cartilages and the erectores and depressores spinæ muscles which erect and depress the rays of the vertical fins of the Teleosts. The muscular bundles which vibrate or abduct and adduct the rays of the anal of Teleosts have a similar origin, and in fact seem to develop from the bundles which also give rise to the erectores and depressores spinæ, and therefore exhibit a similar metameric order of arrangement.

Turning now to the consideration of the *recti abdominales* muscles of fishes, these are metamerically segmented, the segments corresponding to the lower end of the thoracic muscular segments, as is shown in longitudinal sections of embryos of several species (*Amiurus*, *Alosa*). The musculature of the pelvic fin, which is closely affiliated serially with the history of the *recti*, does not in the stages which I have examined show clear evidence of its origin from the muscular segments above it, but such is doubtless the case. The lower ends of those broad membrane bones, the coracoid and clavicle of *Amiurus*, develop in the septa between and above and below the muscular segments of the isthmus, which are clearly the serial homologues of the segments of the recti muscles alluded to above. The hinder coracoid element of the pectoral girdle in *Amiurus* develops in cartilage; the clavicular portion in membrane below the three first segments of the isthmus, the perichondrium of the coracoid above the fourth and fifth muscular segments of the isthmus, counting from in front of to behind the hyoid arch.* It is thus rendered evident that muscular metamerism influences the formation of even the shoulder girdle; and when we bear in mind the fact that such a metameric order was already established during the enterocœlous stage of development, or just a little beyond the gastrula, when the muscular somites were being constricted off from the hypoblast, we may realize how far back in the life-history of an embryo we may begin to trace the influences which determine the ultimate form of the vertebrate skeleton. We saw, for example, that the interspinous cartilaginous bases of what afterwards become the osseous interspinous pieces bear a relation to muscular metamerism; that, in fact,

* In the Salmon the supraclavicle develops as a membrane bone in the septum between the third and fourth muscular segments behind the auditory vesicle; the post-temporal appears in membrane above the post auditory segment, just beneath the skin. The muscles of the pectoral, that is, its abductor and adductor, it appears to me, probably develop from the lower ends of the third and fourth post-cephalic somites. A slender slip of muscle, which is developed from the lower inner side of the upper end of the first post cephalic muscular somite, passes obliquely back from the hinder aspect of the auditory vesicle to be inserted into the upper end of the clavicle. The adductor and abductors of the pectoral are pushed out on either side of the cartilaginous pectoral plate and inserted on its anterior and posterior faces, resembling the arrangement which is permanent in *Gastrostomus*.

these and other elements tended to be formed in the septa between the muscular somites. These septa are evidently "points of rest," so to speak, where chondrification seems to be favored and where the prochondral elements of Strasser * first become defined when a bone is to be preformed in cartilage, or where the basement membrane of membrane bones first appears.

Passing now to the end of the vertebral axis of fishes, we find the same thing verified again. We find the hypural elements, the anterior ones at least, presenting this intersegmental relation to the muscular segments, and finally we discover that the proximal ends of the mesoblastic thickenings which are sent out from the hypural bones towards the margin of the fin-fold, in and about which the permanent rays are developed, rest upon such traces of muscular septa as are not obliterated at the time the permanent tail-fold is formed. Nor does this metameric influence end here, for we find that in the development of the permanent rays a large number of filamentous embryonic fin-rays are fused together by a material analogous to perichondrium, which the embryonic rays themselves simulate, in order to afford the basis for the ossification of the permanent rays. So far-reaching, therefore, is the influence of this metamerism that we are actually enabled to trace its effects even to the formation of the fin-rays.

XIII.—THE MESENCHYME OF VERTEBRATED EMBRYOS.

As Hertwig has shown that the connective tissue cells in certain forms (*Pseudocœlia*) are split off from the walls of the cleavage cavity of the blastula or gastrula stage, we may say that after the genesis of the myotomes a somewhat similar sundering, partly proliferation, of connective tissues from the myogenous and somatopleural tracts of the vertebrate embryo occurs and gives rise to the indifferent tissues, blood, cartilage, and, later, bone. The character of this indifferent tissue is commonly spongy, and is late in developing, just in proportion as the skeleton is retarded in its growth or development. The indifferent stellate cells of this layer, which forms a sort of matrix or envelope for the other tissues, here become metamorphosed into cartilage; then into fibro-membrane; at other points into the endothelium of vessels, &c., so that it gives rise not only to the hard supporting structures of the organism, but also affords the materials for the construction of the channels for the conduct of the functions of irrigation, respiration, nutrition, secretion, and excretion. Its part in embryonic development is thus evidently very important; it, in fact, forms the bond between the other structures—not only affords the means for sustaining the latter mechanically, but also physiologically. It develops secondarily after the triploblastic stage has been passed over in the vertebrate embryo,

* H. Strasser: Zur Entwickelung der Extremitätenknochen bei Salamandern und Tritonen. Morph. Jahrb., V, 1879.

instead of directly from the primary layers during the earlier diploblastic stage, as in the *Pseudocœlia.*

The metameric arrangement of this secondary mesenchyme between and in relation, above and below them, to the myotomes, is also, to a certain extent, a merely mechanical or physical phenomenon, because the outgrowth of the gut-pouches in the primitive *Bilateralia* must have given rise to the existing metamerism of *Vermes*, *Arthropoda*, and *Vertebrata.* The bilateral symmetry of the myotomes and their antimerism are, however, not always exact, as may be seen in both the young and adult of *Branchiostoma.* This gives rise to disturbances in the symmetrical disposition of the secondary mesenchyme.

The blood of all animals is evidently a mesenchymal tissue; and it is noteworthy that while the yelk of meroblastic vertebrate embryos is to be affiliated with the hypoblast, in many cases the peculiar way in which it is absorbed during development renders it mesenchymal. The corpuscles originating from the metamorphosis of the yelk substance are actually transferred from a subhypoblastic position to a mesoblastic one. This, as a number of observers have shown, is effected through an indirect or direct communication between the heart and the surface of the vitellus, from whence many if not all of the first blood corpuscles are proliferated.

XIV.—On the stimuli determining the outgrowth of the lower lobe of the caudal fin.

The hypural lobe of the tail during its outgrowth has a tendency to displace the chordal axis upwardly, as we have noted in the case of the developing hypural cartilages of *Alosa.* Here the development of the hypural elements is accompanied by a pressing inward of the ventral wall of the chorda (Fig. 2, Pl. II). To what extent the upturning of the chordal axis may be due to the deposition of material below it during the development of the ventral lobe, which would tend to displace that axis in an upward direction, it is not possible to state, but it is fair to infer that the energy of growth in effecting displacement here should be considered. But a hasty analysis of this question leads to the conclusion that we are not merely to consider the effects of the outgrowth of the caudal hypural lobe, but the causes which led to such a local hypertrophy of the median fin-fold as to originate this lobe, which we have reason to think must represent a second hypaxial fin which was derived by specialization or hypertrophy from part of a continuous hypaxial series of rays, some of which were also atrophied.

The development of this lobe is essentially similar to that of the other median fins, the medullary portion of which we found was derived from the mesoblast, some of which was pushed outwards into the primitive median fin-fold of the lophocercal stage of development. As further specialization was attained the local suppression of ray-bearing elements has taken place, so that those remaining have been exaggerated

in length and strength, to apparently compensate for this local suppression. Upon further examination we find that the portions which have been retained are situated in the most advantageous positions in respect to their effectiveness as organs of propulsion. This is pre-eminently true of the lower lobe of the caudal, which has been shifted into a position which is lineally in a plane with the vertebral axis. The *mechanical selection* which is here implied, has doubtless led to reduction, just as use and effort or impacts and strains have led to a similar selection of certain axially situated digits in the limbs of Ungulates, whch have thus been hypertrophied, while the extra-axial digits have been atrophied in consequence of disuse. The reduction of the fin-rays and interspinous pieces of fishes has, it seems therefore highly probable, followed from the working of the same principle as I have indicated in my discussion of digital reduction. This general principle is confirmed by every morphological condition which we may choose to select, even if an extreme one is chosen, such as that presented by *Mola*, in which a degeneration and complete loss of part of the caudal axis have led to the assumption of the office of the caudal fin by a series of rays which primitively belonged to the dorsal and anal series. Here the flat, nearly discoidal body, no longer flexible, must develop some new mode of progression. The result is that, as in the above-named genus and the trunk fishes, an extreme modification of the lateral musculature has occurred by which this no longer subserves the use of flexing the body, but the fins only, to which the entire system of myotomes are subordinated, powerful tendons passing outwards to be inserted into the bases of the rays of the median fins.

The evidence in favor of local degeneration or atrophy accompanied by local hypertrophy, which in some cases involves a great change of function in some part, is complete, and we may assert with confidence that such changes must produce great displacement or rearrangement of homologous parts with relation to each other, so that there may arise in this way forms which diverge in the most extraordinary way from what would be considered the typical structure of a group.

Development has rung a great many changes in the evolution of the caudal fin, as we may learn if we take even a very hurried survey of the structure of this organ as found in the different groups of fishes. In some the termination of the chorda has suffered but slight modification or abortion; in others a large amount of the chordal axis has suffered degeneration, as in *Lepidosteus*, and many fossil genera. The development of centra sometimes occurs in some of these forms behind the point where the axis is bent upwards, but in others it ceases abruptly at the point of flexure. In the Salmonoids and *Nematognathi* the development of centra passes beyond the point of flexure, but in these there is a point beyond which almost total degeneracy of the caudal axis asserts itself. This degenerate portion is therefore

exserted to a variable extent in the different forms, and by just so much do they differ as regards the point where the ventral lobe of the caudal grows out even in the embryo, so that traits appear very early in the development of the caudal which serve as marks which characterize the species. The hypertrophy or local outgrowth of mesoblast to form the lower lobe is variable in position to a very great extent, so that the point where displacement due to growth occurs, also varies in position in respect to the end of the chorda. This variation may be well seen in the figures of embryos given by A. Agassiz and other embryologists.

The development of the lower lobe of the caudal by the proliferation of mesoblast and hypertrophy of a part of the hypaxial fin-fold has led to the final elision or suppression in some cases of the larval opisthure, due to a substitution of a secondary or permanent caudal so developed. The localization of the energy of growth in advance of and below the end of the chordal axis has brought about the abortion of the opisthure or what must primitively have formed all of the tail of the ancestral type. But the stimulus which led to the hypertrophy of some part of the hypaxial median-fin-fold must have been the penultimate efficient cause of the development of the opisthure, which becomes rejected or elided by change of function or functional substitution. That stimulus was applied locally to the hypaxial fold, and the hypertrophy which followed was a natural result of use and effort, which very probably arose from the continually-repeated efforts of the animal to rise to the surface to get away from the bottom, and maintain itself right side up, as a result of which the growth of the ventral fold was stimulated and extended ventrally.

This view of the matter is strongly favored by the theory of the median fins which has been defended throughout this essay. The continuous system of median rays found in a perfect condition of diphycercy or the protopterygian stage would be available for a starting point, from whence subsequent heterocercy might arise. The Chimæroid fishes realize this condition, as was well stated by Balfour and Parker,* as follows: "The tail of *Chimæra* appears to us to be simply a peculiar modification of the typical Elasmobranch heterocercal tail, in which the true ventral lobe of the caudal fin may be recognized in the fin-fold immediately in front of the filamentous portion of the tail. In the allied genus *Callorhynchus* this feature is more distinct. The filamentous portion of the tail of *Chimæra* constitutes, according to the nomenclature adopted above, the true dorsal lobe, and may be partially paralleled in the filamentous dorsal lobe of the tail of the larval *Lepidosteus*."

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How near these authors were to a clear comprehension of the true nature of the tail of *Chimæra* may be gathered from the foregoing extract, but I would take exception to their calling the tail of this form *heterocercal;* that it is not, for the chordal axis has not suffered upward

* Structure and development of Lepidosteus. Philos. Trans., Pt. II, 1882, p. 408.

flexure, but the form of the terminal ray-bearing lobes resembles very considerably those of Elasmobranchs, and doubtless some such form anticipated the caudal of the latter.

Their recognition of the caudal filament, or the opisthure of our nomenclature, as homologous with the dorsal lobe of A. Agassiz is also right only in part, because the fin-folds are absent in this case, but present in larval fishes in the lophocercal stage; moreover, the opisthure becomes dorsal in position in the heterocercal forms very soon, but not in a perfectly diphycercal form like *Chimæra monstrosa*, where it is literally post-caudal, being, as a matter of fact, opisthural in position and almost perfectly archicercal in character.

The forms of the lobes of what may be recognized as the true caudal epaxial and hypaxial fins of *Chimæra* agree in their general outline somewhat closely with those of Elasmobranchs, but by no means exactly, yet it is easy to derive the Elasmobranch caudal from the Chimæroid tail, as follows: (1.) Let the opisthure be aborted; (2) lengthen the inferior rays anteriorly, and shorten the superior caudal rays; and (3) flex the caudal axis upward, and we have the heterocercal caudal of the Sharks, provided the neural and hæmal arches or spines are supplied. At any rate, the course followed by the process of evolution in this instance, which leads up to heterocercy, is clear. The diphycercal ray-bearing part of the tail of the Chimæroids is evidently differentiating in the direction of that of the true *Squali*, and that it represents a phase of the evolution of the caudal in the latter is rendered all the more probable from the fact that *Chimæra* is more primitive and more embryonic in many of its characters than the latter. Let the whole axial skeleton of *Chimæra* become more differentiated, and it would doubtless veer towards that of the Sharks in many of its features.

As was remarked before, there is manifestly some stimulus to growth tending to widen the hypaxial caudal lobe and lengthen its included rays. That stimulus seems to us to be use and effort exerted in the course of existence or during life, and through which the local activity of nutritive processes is modified through the fluctuations of blood-supply needed in carrying on nervous and muscular action. The sculling action of the flat tail of *Chimæra* in rising toward the surface would necessitate the greatest exertion of effort by the lower lobe of the caudal, and thus initiate such a differentiation as is demanded by the foregoing hypothesis. For reflex activity or response to stimuli begins to be manifested not in the finished metazoan organism as a whole, but has its ultimate source in the histological elements or cells of which such an organism is composed, an opinion with which I think it probable most careful embryological students who have studied much live material will agree, as it is not meant here that what are known as reflex actions involving molar movements of masses of bone, muscle, &c., include all that is truly comprehended by reflex activity, which may in reality be exhibited by the tiniest speck of protoplasm. In fact, all the

reflex actions of higher animals are finally reducible to molecular disturbances and more or less spasmodic exhibitions of contractions of aggregates of plasmic bodies in response to nervous stimuli or impulses generated at the periphery as sensations and finally sent back from the nervous centers as motor impulses of the organism which regulate and co-ordinate the contractions exhibited in the course of vital work in the struggle for existence. All of the energy so exhibited is not dissipated in the visible movements of the animal, but some of it is unquestionably consumed in inducing morphological alterations or adjustments, in maintaining a physiological equilibrium, in other words; or, as happens in a mechanical device, some force is consumed in overcoming friction. This kind of an equivalency between a certain residual part of the energy expended by an organism and the energy needed to be used in the acquirement of new organs is clearly correlative and conservative. The acquisition of new organs may therefore very probably be viewed as a problem of physiological dynamics, in which a certain equivalency between the work done, the bulk of the living mass, the distance through which movement is made, and the duration of the effort exerted will be taken into account so as to get at a residual element of potential and dissipated energy used up in maintaining and readjusting the organic aggregate to new conditions. The development of new organs is evidently a progressive process, as our study of the evolution of fishes' tails has shown, for it is hardly possible to conceive that the ascending order of differentiation indicated by ontology and palæontology can be in error, since that order is approximately as follows: archicercy, lophocercy, diphycercy, heterocercy, homocercy, and gephyrocercy.

When an aggregate of plasmic units or an organ, such as a muscle, is stimulated to contract for the first time in response to a new or extraordinary effort, increased waste follows, which must be made good by increased nutritional activity in that part. More blood is therefore sent to such parts momentarily, the remarkable vaso-motor system of nerves being involved in effecting this in higher organisms. In simpler organisms, however, no provision of vessels and vaso-motor nerves exists, and the acquisition of pabulum may be effected in some cases by its mere transfer from cell to cell, as is the case in many processes of embryonic growth. The very remoteness of the peripheral plastids from the nutritive and respiratory centers in higher organisms has led to the evolution of the vaso-motor and vascular systems, so as to provide for the reflex exhibition of the needs of remotely-situated groups of plastids when extraordinary exhibitions of effort are in progress in such groups, and thus enable their immediate wants to be supplied. Such systems are beyond the control of the will as expressed and exerted under the guidance of the rational faculties, and they minister to the demands of the aggregate of the wills, so to speak, of aggregates of remotely-situated plastids calling in this way for oxygen and food. This cellular volition is the exhibition of the low protozoan grade of reflex action

when possibly the nucleus was the center receptive of external impressions, the reflex energies being in turn propagated from it. While all of the foregoing is speculation only, it helps us greatly to understand some of the phenomena encountered in the course of the development of new organs, and aids in giving us a somewhat clearer comprehension of what is meant by such terms as "automatic" and "voluntary actions." Enlarging upon what has been said above, it may be said that automatism is pronounced in certain organs directly in proportion to the grade of specialization attained by the animal, and that the automatism of tissues is due to the survival not only of the protozoan grade of differentiation of their elements, but literally to the survival of elements that are in detail structurally comparable to *Protozoa*.

It will thus be seen that an action which had its origin, we will say, in an effort of the will of a higher animal as ordinarily understood, has evoked a secondary set of phenomena which had their origin in an automatic set of organic elements, and which have at their command the vaso-motor and vaso-accelerator systems in such higher forms. When such an adjustment and distribution of functional effort become approximately stable, the species itself becomes approximately so. Let any new demand of the environment arise, however, and a recoördination of the functions must take place, which leads to a redistribution of organic matter and organic motion, which must continue until such a recoördination is completed.

The method of recoördination seems to be contemporaneously increscent and decrescent in different parts of an organism by small degrees, and these two processes are apt to affect each other reciprocally; that is, while one part is growing and becoming able to assume its function, some other structure which previously had the same or a similar function is degenerating, just as we saw that the permanent caudal replaces by such a process of substitution the lophocercal tail of larval fishes. Other instances occur where the atrophy is complete, and no structure functionally comparable is developed, as in the case of the larvæ of Anurous Batrachians, in which total atrophy of the larval tail takes place, in consequence of a process of physiological disintegration of this part, which occurs relatively late, and in the course of which the material so torn down is reintegrated into new structures near by, having a totally different function, as in the case of the hind limbs of these animals, which violate the general rule which obtains amongst the embryos of *Vertebrata* by budding out as paired rudiments before any traces of front limbs have shown themselves externally, they being concealed under the opercular membrane. The tendency of all other vertebrate embryos is to develop the anterior limbs first; and even in the case of the Kangaroo, among mammals which have the hind limbs so disproportionally enlarged in the adult, their rudiments in the very immature embryo taken from the uterus of the parent are, according to Chap-

man, disproportionally small, as compared with the rudimentary front limbs, and present only as a pair of minute papillæ.

The rapid and accelerated outgrowth of the hind limbs of the embryos of *Anura* becomes partially explicable on the ground that the disintegration or rapid metabolism, involving the tail, which occurs during their larval metamorphoses, happens very near the point where the hind limbs are to grow out, and thus places in close proximity a supply of available protoplasm, ready to be used in thus precociously accelerating the outgrowth of these appendages, which probably represent, in part at least, the reintegrated substance of the tail, which had developed so far as to have a chordal and a nervous axis, together with a long series of myotomes on either side before its singular retrogressive metamorphosis began.*

The part played in this metamorphic process by certain cells, denominated *phagocytes* by M. Metschnikoff, is very significant, and his conclusions, as given in a short extract below, as bearing upon pathological phenomena involving muscle and nervous tissue, in such cases as were long before described by Rayer (Mém. de la Soc. Biol. de France), are of the highest interest. Not less interesting to the writer are the conclusions of Metschnikoff as illustrating the possible origin of the vaso-motor system in the way in which it has been discussed above, since he speaks of "a struggle between phagocytes and septic material." This struggle implies that the phagocyte includes a sensitive center or reflex sensorium lodged somewhere in its substance, in virtue of which it practically manifests reflex actions like an organism of the Protozoan grade. In the metamorphosis of the Batrachian tail, which is literally eaten up phagocytically, so to speak, by internal wandering cells, we have an instance of the normal exhibition of phagocytic action.

"The tail of the Batrachia, during the early stages of its absorption, contains a number of cells, which, when left undisturbed, throw out fine radiating pseudopodia; these contained remnants of nerve-fibers and muscle-cells. Phagocytes, then, play as important a part in the metamorphosis of Batrachians as of Echinoderms; and pathologists have afforded evidence of their agency in the so-called active degeneration of muscles and nerves.

"The author has tested in a *Triton* the theory he holds as to the phenomena of inflammation in Invertebrates being primitively nothing more than a collection of phagocytes assembled to devour the exciting object. He touched the point of the tail of a *Triton* with a small piece of nitrate

*To what extent I may have restated in the two preceding paragraphs, in another form, what E. Ray Lankester has said before me in his book on Degeneration, or what Dohrn has stated in his essay entitled *Der Ursprung der Wirbelthiere und das Princip des Functionswechsels*, I do not know; but I have ventured to give the preceding examples in order to illustrate the reciprocal relation existing between degenerative processes involving transient organs and the formation of permanent ones, without having previously read either of these authorities, or knowing what their general conclusions were.

of silver and then washed it with salt solution. Branched connective tissue cells collect around the inflamed spot and eat up blood corpuscles, carmine granules, and particles of pigment. * * * When a fully-gorged phagocyte dies it is immediately devoured by another. Inflammation then is not, as is ordinarily supposed, due primarily to a morbid condition of the walls of the blood vessels; it is a struggle between phagocyte and septic material, and it is in Vertebrates alone that the vascular system, owing to the insufficient number of extra-vascular phagocytes, takes part in the struggle."*

The exaltation of metabolism shown in phagocytic phenomena accounts for the rise in temperature when they are manifested in the higher forms. It is not singular that the storage of proteids in cells should occur in certain cases, especially where these are destined to become greatly exaggerated in amount in order to afford the pabulum from below to the growing blastoderm and embryo, which is superimposed upon a supply of proteinaceous matter known as the *yelk*, which in turn is literally consumed by cells of hypoblastic origin (megasphæra) or by a plasmic layer standing in a similar relation to the embryo, as fast as the yelk material is needed for the growth of the latter.† The primitive egg-cell of the ovary may, therefore, in one sense, be looked upon as a phagocyte of a special kind in such forms as develop a yelk.

Just beneath the hypoblast of the yelk of the Rays there exists a stratum of singular amœbiform cells, which are much branched and irregular in form. They are not in contact with each other except by their pseudopodal prolongations. They contain coarse granules in the central parts, which are doubtless disintegrated vitelline tablets which have been taken in from the true yelk below and converted into their own more mobile protoplasmic substance. These bodies are quite outside of and below the hypoblast and vascular mesoblast. The apparatus for the absorption of the yelk of the Elasmobranch vitellus is therefore quite different from that which is found in the Teleosts, as may be learned upon consulting the papers by the writer last cited, where he has described the homogeneous converting layer in the eggs of the latter group, calling it the *yelk hypoblast* for reasons which appear valid, because its function is a temporary one, the structure disappearing with the necessity for its existence.

The quasi-phagocytic action of primitive ovicells,‡ in consequence of which the germinative vesicle or nucleus suffers displacement, just as the cells of the notochord and adipose tissues have their nuclei displaced

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*E. Metschnikoff. Quar. Journ. Mic. Sci., XXIV, p. 112–117.

†Development of the Silver Gar (*Belone longirostris*), with observations on the genesis of the blood in embryo fishes, and a comparison of fish ova with those of other vertebrates. Bull. U. S. Fish Comm., I, pp. 283–301, 1881.

Observations on the mode of absorption of the yelk of the Embryo Shad. Bull. U. S. Fish Comm., II, pp. 179–187, 1882.

‡ The law of nuclear displacement, and its significance in embryology. Science, I, 1883, pp. 273–277.

by the absorption of water, or the formation of oil, or by the incorporation of large amounts of plasmic matter is remarkable; yet there are phenomena met with which are apparently the very reverse of anything comparable to phagocytic; these are such as show minute granular bodies developed outside of the vitellus and between it and the egg membrane, as occurs in the case of *Amiurus albidus*,* in which the granules are quite free. In the young Spanish mackerel somewhat similar granular bodies lie beneath the skin and represent a homogeneous stratum found largely developed in the fin-folds of the embryos of certain forms, as in *Alosa*, for example. C. Emery first called attention to the existence of this homogeneous substance in the fin-folds of the lophocercal stages of young Teleosts in a memoir† published about a year since. He regards this substance as a secretion; that is, it is *mesenchymal*, and may be derived from the mesoblast, the epiblast also taking a share in its formation, and may possibly be comparable to the body of the gelatinous substance found in the umbrella of Medusæ.

This homogenous stratum precedes the cellular mesoblast in its advent into the fin-folds of fishes, but it may be doubted if it has any influence in determining heterocercy further than that it may supply the material which is eventually converted into cellular mesoblast. In thus tracing the causes and phenomena which are directly concerned in inducing heterocercy, or which collaterally throw some light upon it, it becomes very evident that it is a very complex problem, but this is no reason why its elucidation should not be attempted.

XV.—On the movements of parts of living bodies considered as the causes of morphological differentiation.

It is noteworthy that the *Lyrifera* is the only group of Vertebrates in which the termination of the axis of the body is commonly and fixedly upturned, and this, together with the usual development of mesial basalia for the support of the true fin-rays, which basalia extend outward usually to the level of the integument covering the body of the adult, and in contact or not in contact proximally with apophyses of the vertebræ, constitute two of their most frequent, though not absolutely constant, characters. The dorso-ventral symmetry of the terminal caudal skeleton is thus more or less impaired because of this departure from the usually almost rectilinear form of the vertebral axis of the *Ichthyopsida* and the Lacertilian phylum of the *Sauropsida*.

The other groups of *Vertebrata* present differentiations of their vertebral axis, which may be regarded merely as other departures from the nearly rectilinear series of vertebral segments of the lowest Vertebrates.

* Preliminary notice of the development and breeding habits of the Potomac Catfish. Bull. U. S. Fish Comm., III, 1883, pp. 225–230. Such granules are also found floating inside the egg-membrane and around the embryo of *Thymallus*.

† Sulla esistenza del cosidetto tessuto di secrezione nei vertebrati. Atti della R. Ac. delle Sci. di Torino, XVIII, 1883.

These higher groups seem to fall into six arbitrary categories, habitual movement in particular ways having brought about the special modifications.

Professor Marsh* in speculating upon the origin of the forms of the vertebræ of the different groups of Vertebrates reaches the following conclusions:

"(1) *Biconcave vertebræ* (Fishes and Amphibians): the primitive type; a weak articulation, admitting free but limited motion. From this form have been directly derived the other varieties, namely:

"(2) *Plane vertebræ* (Mammals): affording a stronger joint, with motion still restricted.

"(3) *Cup and ball vertebræ* (Reptiles): a strong and flexible joint, well fitted for general motion, and evidently produced by it. The vertebræ are procœlian when lateral motion is dominant (serpents); opisthocœlian with varied motion (Dinosaur cervicals).

"(4) *Saddle vertebræ* (Birds): the highest type; a very strong and free articulation, especially adapted to motion in a vertical plane, and mainly due originally to its predominance. (Is predominant in the cervical series.)"

Professor Cope has found a fifth type of vertebral column in a reptilian type from the Permian formation of Texas, in which there are lateral and inferior intercentral pieces wedged in between the true centra of sucessive vertebræ. The vertebral column of this type, which represents a very important group, which he calls *Theromorpha*, thought by him to be ancestrally related to the oviparous Monotremes, he thinks was developed by the peculiar lateral flexures to which the vertebral axis was subjected. Further studies may throw some additional light upon the mode in which the supplementary intercentra were formed in this group, as special or peculiar conditions have evidently determined this singular morphological differentiation.

A sixth type is found in armor-bearing forms, as in the extinct Armadillos and the recent and fossil emydoid *Testudinata*, which has been developed in consequence of a loss of mobility of the axial column due to the existence of an inflexible outer carapace, as pointed out by Spencer and myself.† In what way this degeneration of the centra has been developed in the fossil Armadillos has been discussed by me in the paper cited, as follows: "The carapace was supported for nearly half its length upon the haunch bones (ilia and ischia), as well as by the strong, longitudinal, median, bony crest rising from the lumbar and sacral vertebræ, consisting of their united neural or spinous processes. The carapace rested directly on these bones, and was joined to them by suture, as the roughened and expanded surfaces for such juncture show. The entire union of the lumbar and sacral vertebræ into a

* Birds with teeth. Third Ann. Rep. U. S. Geol. Surv., 1881–'82, p. 82.

† The gigantic extinct Armadillos and their peculiarities, with a restoration. Pop. Science Monthly, XIII, pp. 139–145, 4 figs. in text.

hollow bony bar, and the union of this to the lateral elements of the pelvic arch, together with the union of both by suture with the carapace, rendered any lateral bending of the trunk impossible, so that an almost universal union of the trunk or body segments ensued, owing to this structurally enforced loss of mobility between the vertebral elements. As a consequence, the centra or bodies of the segments disappeared or were atrophied, leaving only their trough-like plates about one-fourth of an inch thick, formed of the degenerate united central bodies. This trough, with the united rib-bearing arches which arose from its edges, formed a tube for the lodgment and protection of the spinal or nervous cord. Unlike all other Vertebrates except Turtles, this tube, in that portion over the lungs, is perforated at intervals on each side, at points about midway of the length of each one of the united segments, to give egress to the spinal nerves.* The points of egress for the spinal nerves are usually between the spinous processes in other orders of Vertebrates.

"In living Armadillos the centra of the trunk vertebræ still remain as more or less depressed cylinders of bone, or, at least, they are distinguishable as centra, from which arise the rib-bearing arches, which do not completely unite, leaving lateral interspinous openings so as not to entirely close over the nervous cord, as happens in fossil forms. The reason why the vertebræ remained separated in recent species is undoubtedly because of the mechanical conditions to which these parts of their skeletons were subjected. Here the carapace was jointed and flexible, hence the need of flexibility in the spinal column. In the extinct species, as in Turtles, the degeneration of the centra into mere conduits for the nervous cord is one of the many contrivances the origin and teleological significance of which can only be explained by a mechanical theory. The vertebral column in both was similarly conditioned with respect to strains, mostly transverse—hence the similarity of structure, which it must be borne in mind is, however, no indication of zoological affinity.

"Beginning with the homogeneous notochord or rod-like axis of some such form as *Amphioxus*, Mr. Spencer points out how, as this axis became bony with the assumption of the characters of the higher fishes, the alternate pressure and tension incident to the flexures of this axis during locomotive acts would tend to differentiate the vertebral segments; for it is obvious that, in order to be flexible and at the same time bony, the vertebral axis must become segmented. The mechanical conditions under which vertebral axes are placed would indicate that the segmentation took place from within outwards, which is in accordance with observed facts. It is also obvious, in view of the premises, that, in the absence of flexures or bendings of the vertebral axis, we should have a return to the homogeneous structure [now replaced by a continuum

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* In birds, as, *e. g.*, the common fowl, the first segments of the sacrum, the centra of which are similarly atrophied, are perforated laterally in the same situation.

of bone], such as we actually find to result in the two cases under consideration, and as happens in a few of the posterior trunk-segments (sacral) of birds and mammals. Embryology and phylogeny both bear out these conclusions. Not only do the vertebral centra become more rudimentary as the young condition is departed from during the life-history of the individual tortoise, but the centra also become successively more rudimentary as we pass from the less completely armored genera *Sphargis* and *Trionyx*, to the more completely armored *Testudo* and *Cistudo*."

The data respecting the mode in which the primitive membrane of the rays of fishes is fractured and thus segmented evidently apply to the genesis of vertebral bodies the membranous basis of which invests the chorda as a continuum at first, its continuity remaining unbroken on the inferior face of the trabeculæ cranii, where it gives rise to the parasphenoid bone of fishes. The points of fracture of the osteogenetic membranes investing the chorda, which herald the subdivision of said membrane into the foundations of vertebral bodies, correspond homonomously in position with the intermuscular septa between the myotomes. These phenomena probably never occur till the embryo begins to make voluntary movements in the egg, egg-follicle, or temporary uterus in the lowest forms; such at least seems to be the case with the embryos of the *Ichthyopsida*.* Such interpretations of the genesis of structure bring the phenomena of development under the domination of natural law, and accept little or nothing in common with old-fashioned teleology, that inane creation of mystical metaphysicians, whose anthropomorphic preconceptions have hindered the progress of biological science for not less than two centuries.

Looking in an unprejudiced way upon a living body, we are forced to admit, after the strictest investigation, that its "vitality" is only one of many special modes in which matter may exhibit phenomena of motion or action. If life is a continuum in virtue of the fact of the production of germs, from which new and similar organisms may grow; if likewise the energy of an actively living, growing body is continuously exhibited, then that energy must be continuously expended, and food must be constantly appropriated, and as constantly must there be material waste in progress.

Newton's third law of motion states that "Action and reaction are equal." If, therefore, it is true that the body is continuously in action, it must be true that there is continuous reaction going on in the most ordinary voluntary physiological work done by the body. Further, we

* It is of some interest to note in this connection that distinct diarthrodial articulations of the heads of the ribs with the vertebral bodies never occurred in the Vertebrates until the differentiation of the pneumatic respiratory apparatus. This articulation is changed to a sutural one in the Turtles, in consequence of the suppression of the thoracic respiratory movements of the ribs by the development of the rigid carapace to which the latter become fused.

can have no reason to doubt the fact that the energies of the universe are otherwise than continuously exhibited. The organism, like a planet, is bounded by a form; theoretically it is separated temporarily from the rest of the cosmos just as the former, but it is a parasite, crawling, walking, running, flying, or swimming, on or in the various media found on the surface of the planet. The organism is individualized like the planet, but the energies of both are reciprocally antagonistic. Action and reaction are equal and continuous in one sense. The energies of the planet and the cosmos, taken together, are, however, too great to be overcome by these superficial parasites, and in consequence of their small mass they must accommodate themselves, adjust themselves as the pull and push of the vast planet under them determine. They are modified in structure by their own actions and the reactions of the environment, or die if they fail to succeed in effecting this adjustment, a process in which their volition is of small effect in changing the result, because what will they may have must bend and adjust its demands to the demands of far stronger outward forces. The naturalist encounters upon every hand evidences of the effects of the struggle of the organism with its environment. This struggle is so real, so tangible, that it becomes palpable in every movement made by the body which calls for effort in its execution. It is the most continuously operative of all the forces of nature, effectual as modifiers of organization. There exists not a single bone known to the osteologist which does not bear the evidence of having been directly or indirectly modified in the course of the conflict between the organism and its environment, in consequence of the interaction between the forces of the latter and those exerted by nature. It will thus be seen that all the forces that are originative, except such advantageous actions as spring from acquired intelligence, are ultimately to be sought in the energies with which an organism has to contend during each and every moment of its existence. The beautiful adaptations which appeal so strongly to the teleologist are only the result of the action of natural forces which originally determined the deposition of inactive, active, sensitive, or contractile materials at definite places in a living body in sufficient proportional amounts to fit it to meet the demands made of it in relation to its environment.

This is the origin of "fitness," in precisely the same sense in which we may contemplate the origin of the equilibrium existing between the planets. A certain dynamically determined fitness, therefore, precedes the process of natural selection, from which the latter draws its material and upon which heredity fixes its stamp; but heredity, be it remembered, is not a whit more indebted to the action of natural selection than it is to the operation of those far more powerful interacting energies which primarily ordain adaptations.

The desire to get the most pleasure with the least exertion is probably a universal character of the habits of organisms, and those which,

by stealth or by taking advantage of favorable environing conditions, can make use of such with but little effort doubtless often surpass the strong in the race for survival; but it must be borne in mind that this is only the practical expression of the doctrine of economy of effort or that of "least action," so that in a literal sense the degenerate loafers, blood-suckers, and parasites of the organic world are simply such types as have availed themselves of the favorable nidus which those higher free organisms which have been "heroes in the strife" afforded them. This takes into account the effect of intelligence in favoring the merely physical processes of evolution which lead to the morphological differentiation of organisms.

It may be objected that the views here put forth imply that the organism may be compared to a machine, and it may be well, once for all, to show why such an opinion is untenable. Two reasons show that such an hypothesis is untrue: first, unlike any machine, an organism repairs itself; and, secondly, unlike any machine, it first converts food into itself, then disintegrates part of itself in order that energy may be freed to conduct physiological or living actions. There is therefore no parallelism between the action of an engine of any sort and a living being. Further, no stimulus is capable of causing the liberation of energy from the component parts of an engine or mechanism, whereas the molecular instability of living matter is so great that a great number of stimuli may induce the liberation of some of its matter and energy and thus set the organism or some part of it a-moving.

The energy of live matter and that of the environment being in a constant state of interplay and antagonism, it follows that there is continual adjustment going on, as may be seen all round us in the attitudes we assume, as in the act of respiration, for example, which is a common and familiar instance of these incessant processes of adjustment, and it is so important that these should continually proceed that it is hard to realize at this late date that more of us should not be ready to accord a paramount influence to such causes in the determination of organic form. While the oxidation and decarbonization of living matter seem to be the processes that lie at the bottom of the incitement of the movements of animals, it is probably true that an organism once having reached a condition of stable adjustment retains its typical form, and is thus rendered more or less stable under uniform conditions as a species; yet all of us are aware to what extent a species may be variable.

The variations which we encounter in nature in the form of the bodies of animals and their structures are in all cases to be ultimately traced to the effect of the environment in calling forth adjustments. The forms of the fish, of the bird, of the mammal, &c., are familiar examples, and it is therefore manifestly vicious reasoning, as pointed out by Spencer, Darwin, and Parker, to look upon these types as a lineal series, as approximately expressed in the older classifications. On the contrary, they must necessarily be divergent, and by just so much as they have

diverged are they thrown out of the direct line of descent, as in the cases of the Anurous Batrachians and Teleostean fishes, for example, each of which is an example of a high state of evolution, and mark extreme adaptations, which cannot therefore have any very close affiliations with other series. Besides all this, the record of the process is so blurred by adventitious adaptations, in consequence of the interaction of organs upon each other through substitution of function, inducing degeneration, or by special adaptive modifications, that real affinities are often much obscured and rendered difficult of determination.

Degeneration or abortion of certain structures, as well as the degeneration or degradation of a whole organism, not unfrequently results from such causes as involve the disuse of a certain set of structures and their atrophy, or extensive modification and changes in adjacent structures. This may be illustrated by the fact that vertebral segments are clearly indicated in the fore part of the chorda of the embryos of *Amiurus*, where five of them subsequently coalesce and a single compound segment is formed, due to a loss of mobility enforced by processes of the post-temporal bones coming into contact with the lateral processes of the anterior vertebræ. This also results in causing the abortion of about the same number of myomeres in this region and their confluence into a great muscular mass without any intermyomeral septa developed between them. This also reacts upon some of the ribs, which are also confluent or developed as a continuous osseous plate in the rib-forming layer of the embryo. The anteriorly bifurcate air-bladder encroaches as it becomes larger upon the lower end of the anterior myotomes, the pressure thus caused seeming to induce the abortion of the lower end of the latter at this point. The air-bladder, as it grows out from the fore-gut, finally has its parietes brought almost in contact with the integument just behind the pectoral arch, where it may act as a tympanic organ in connection with the internal ear, as already suggested by T. J. Parker in regard to a similar structure found in front of the pectoral arch of the Red Cod. In very young embryos of *Amiurus*, or those of the second day, the muscular segments are developed immediately behind the pectoral plate and fold in just the same way and as strongly as in the young Salmon of the same relative age, in the adult of which there is no such abortion of the muscular side walls of the anterior part of the visceral cavity. We have thus seen what a remarkable series of modifications result correlatively from a change in the mode of development of one or two adjacent parts.

As the results of direct pressure exerted rhythmically we have the superficial layers of cartilage cells overlying the articular ends of the bones of the limbs flattened, as Professor Leidy long ago suggested in explanation of this condition.

In the case of the dental armature of the Mammalia, I have sought to show that the crowns of the teeth, especially in the *Herbivora*, have been altered by use on the supposition that the enamel and dentine

were more or less permanently flexible, in consequence of which the rhythmical pressure exerted in mastication and in a constant direction flattened and modified the primitive cusps of the teeth of the early Tertiary bunodonts, causing them to become gradually selenodont, as we actually observe to be the case when a series is examined the members of which come from successively later and later horizons.

The apparent correlation between the degree of complexity of the crowns of the teeth of the equine series and the degree of digital reduction can be regarded as such only so far as two distinct mechanical forces have operated continuously and contemporaneously. Many other instances of correlation may doubtless be similarly explained.

When we look about us and find that certain phenomena are caused by natural forces acting in certain well-defined uniform ways, we say that the phenomena and effects produced are natural ones. That they are determined in an approximately invariable manner we must infer from the fact that the effects are alike or similar. Coincidences of this kind occur in very great numbers in morphology, and there are few students who have not had them forced upon their attention during their investigations. Such series of similar effects imply the existence of similar causes, as, for example, the presence of selenodont teeth in Ungulates which move the mandible laterally, and bunodont teeth in those Ungulates which exhibit no lateral movements of the mandible. Such coincidences are too numerous to be regarded as accidental, and much as Dr. Tomes may desire to deny the real efficiency of a force generated by the muscles of an organism to produce changes of form in already developed hard structures, such as enamel and dentine, such a force nevertheless undeniably exists and produces its effects, as may be inferred without chance of error from the fact of the very existence of these very same numerous coincidences found in numerous recent and fossil forms. Facts communicated to me by dentists show that abnormal pressure may alter the form of a tooth during its growth and within a comparatively short period; yet Dr. Tomes has the hardihood to assert with great assurance the very contrary, without ever once having properly read my papers or having analyzed the data involved in the discussion.

Since natural selection cannot account for the origin of the reversal of position of the crescents in the crowns of the opposing series of teeth, for hundreds of other patterns would have answered just as well, or for the invariable coexistence of such a crown-pattern with lateral mandibular movements, in what manner are Dr. Tomes and those who agree with him to extricate themselves from the position in which their callow haste has placed them? It is very clear to me that the awkward position in which the English odontographer has placed himself will sooner or later dawn upon his consciousness.

The case of the teeth is a very strong one, and there can be no escape from the conclusion that here, as in the case of the evolution of the

tails of fishes, natural selection is utterly incompetent to account for a too numerous series of coincidences which afford the most impregnable inductive basis for a theory of mechanical or dynamical evolution. The rule that similar acts govern or are associated with the production of definite morphological modifications is too clearly made out to be broken down by any *a priori* reasoning.*

I have sought to show, in a paper on the laws of digital reduction, how the expenditure of the energy dissipated in the act of locomotion, if exerted by way of the middle series of digits, those finally usurped the whole function of the original five, the lateral ones becoming rudimentary. How in like manner the difference in the number of digits in the fore and hind feet arose, assigning as a reason that whichever pair was subjected to the severest strains was most apt to have the digits reduced in number, as in the case of dogs, kangaroos, rabbits, &c., which habitually make more or less rapid and successive bounds in running.†

In now reverting to this subject, with a greater array of details in defense of my position, I must admit that the views expressed by me five years ago‡ were in accord with those expressed by Spencer in relation to the genesis of bilateral symmetry, since shown to be not altogether in harmony with the results of embryological research. The principle then stated, that the alternate bending of the soft rays of fishes from one side to the other led to their segmentation, I however still hold to be true, for the reason that the primitive embryonic rays are never segmented, but only after they have been blended and invested by membrane substance, to form the matrix of permanent rays, and when the muscles are already formed which move the latter, do the rays show any evidence of transverse segmentation. This is the nearest attainable approach to a demonstration that the alternate swinging movement from side to side of the rays of fishes by the muscles has to do with their transverse segmentation, since this segmentation is always developed secondarily and after the membranous basis of the

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* Professor Cope, Science, IV, No. 87, 339, in an abstract of a paper by him on the phylogeny of artiodactyle Mammalia, "considered the derivation of the selenodont dentition from the bunodont as established from a mechanical point of view."

The evidence in favor of dental specialization of Mammals as modified by the mechanical movements of the animals may be found in a series of papers by the writer, published during the years 1877 to 1879, and based on observations made on the living animals, as well as on the dentitions of living and extinct forms. See Am. Nat. 1877, 603. Nature, XVII, 1877, 128. On the mechanical genesis of tooth-forms, Proc. Acad. Nat. Sci. Philada., 1878, 45–80. The significance of the diameter of the incisors in rodents, Proc. A. N. S. Philada., 1877, 314–318. On the evolution and homologies of the incisors of the horse, Proc. A. N. S. Philada., 1877, 152–154. The mechanical genesis of tooth-forms (Abstract by C. N. Pierce), Dental Cosmos, XX, 1878, 465–472. Further notes on the mechanical genesis of tooth-forms, Proc. A. N. S. Philada., 1879, 47–51, and in a Review by E. D. Cope, Am. Nat., 1879, 446–449.

† On the laws of digital reduction. Am. Naturalist, Oct., 1877, pp. 603–607.

‡ On the origin of bilateral symmetry and the numerous segments of the soft rays of fishes. Am. Naturalist, XIII, 1879, pp. 41–43.

permanent rays is fully formed. It is also noteworthy that the most embryonic or solid type of rays, namely, those found in the *Dipnoi*, are not transversely segmented, apparently for the reason that they are not ossified, but retain very much the constitution of the embryonic horny fibres found in fish embryos. The Teleosts have the basal portions of the rays unsegmented, especially those proximal portions which are invested by muscles, as is the case with the caudal rays of many forms. The distal portions of the rays with their branches in Teleosts and Sturgeons are segmented and ossified. In young fishes the segments are relatively longer than in the adult, thus indicating that the number of segments of the rays increases with age, as I know from observations made on the development of the caudal rays of *Amiurus*, in which the segments are at least three times as numerous in very old specimens as in young ones, fifteen days old. This would indicate that the active movement of the fins, as the fish grew larger, caused the semitubular halves of the rays to fracture at more and more points so as to give rise to the increased number of segments. That such fracture does take place may be assumed upon the basis of the investigations of Lotz* and myself.

Lotz figures the point of fracture of a ray of the caudal of the young Salmon in which it is shown that the ends of the segments are jagged, as if broken (Fig. 3, Pl. III), and the membrane is thickened where they come together as if the ends had been bruised by pressing against each other while the whole ray was being bent. In *Amiurus*, in which I have studied this point, I do not find the broken, jagged ends of the semitubular radial membrane so much thickened, as shown by Lotz in the Salmon, but there is a distinctly defined interval between the membranous segments, which appear to be held together externally and internally by a thin membrane or sort of ligament, which is very thin and consists probably of fibrous connective tissue. These observations have been made upon longitudinal sections of caudal rays, so that there could be no chance of error in my interpretation of the essential facts. They show in the most conclusive manner that mechanical strains upon the membranes when the rays were in use as propelling organs had fractured them at the points described. Moreover, these points of fracture were found to very often coincide with those of adjacent rays, so that a slightly curved line drawn from the break in a central ray would cut through similar breaks in line with the first in the other rays lying on either side of the former.

Here we have an instance in which the breaks in a number of adjacent rays took place concurrently in time and coincidently in position, along a curved line with a generally transverse course across the fin. The probability is that whatever combination of conditions determined the first break in any ray along that line favored the formation of

* Ueber den Bau der Schwanzwirbelsäule, &c.

breaks in those adjacent, for the reason that a break in one would weaken the support of the rays on either side.

The efficiency of physical forces as the causes of such phenomena no reasonable investigator can for an instant doubt, and to cry out against such a mechanical or kinetic process of evolution as here supposed, which has been assumed by critics not to convey any information, is to do no more than reject the truth; while to put natural selection in its place is not only illogical but absolutely absurd, because this mechanical method of developing the segments of the rays of Teleosts is repeated in every young fish the adult of which has segmented, well-ossified, branched rays. Survival of the fittest, or natural selection, has nothing to do with the process here under discussion, because whether the fish survives or not to become adult, the fracturing and segmenting of the rays has already happened by the time the rays are fairly formed, and when the animal is only fifteen days old, and is still very far from mature or in condition to transmit to its offspring the disposition to segment the fin-rays. It might be urged in objection that the disposition or the structural conditions favoring this mode of segmentation of the rays was inherited. Granting even that much, it does not dispose of the fact that the segmentation or fracturing is veritably caused by the mechanical resistance offered to the fins when the young animal, with developing permanent fin-rays, moves the latter. Moreover, it is undoubtedly true that the period when this segmentation occurs in the rays of the very young fish, the latter does not represent an older ancestral type, for the reason that the degree of rigidity caused by the extent to which ossific deposits are laid down during farther growth determines the number or frequency of the points of fracture, which increase in number with the advance in age.

XVI.—Lamarck's share in the development of the principles of dynamical evolution.

As Darwin and Haeckel have truly said, Lamarck is the real author of the doctrine of the evolution of organisms or the theory of the transmutation of species, as effected by the operation of natural causes controlled by natural law. Others before or shortly after him seem to have had some sort of dim conception of the same thing, but let us note how forcible and pregnant some of his ideas were which he put forth in the introduction to his great work entitled *Histoire naturelle des Animaux sans Vertèbres.**

On page 14 of that *Introduction* these fundamental principles find a place:

"First principle: Every fact or phenomenon of which observation makes us cognizant is essentially physical, and owes its existence or production to some body or to the relations between bodies."

* Tome I, Bruxelles, 1837, 3d edition, revised by Deshayes and H. Milne-Edwards.

"Second principle: Every movement or change, every active force, and every effect whatsoever observed in a body depends necessarily upon mechanical causes, regulated by their laws."

"Third principle: Every fact or phenomenon observed in a living body is at once a physical fact or phenomenon, and a product of organization."

"Fourth principle: There is not in nature any matter which is possessed of the peculiar faculty of *living*. All bodies in which life manifests itself present in the organization which they possess, and in consequence of which movements are excited in their parts, the physical and organic phenomena which constitute life;* phenomena which are executed and maintained in the body as long as the conditions essential for their production subsist."

Now that protoplasm itself is beginning to be regarded as not utterly devoid of structure, and not a simple body, but a complex of many, how much more significant these utterances of Lamarck become. The progress of biological research also tends to show that growth and segmentation of simple cells is an exceedingly complex phenomenon, and that the very first steps of development are remarkably so, and that disturbances of the molecular energies of the germinative vesicle may lead to the production of double or triple monsters by mere multiple impregnation, as shown by Fol in the course of his investigations upon the development of the Star-fish. These and other investigations have cast doubt upon the hypothetical *Moncrula* stage of development, which is such an important part of a popular but now, probably in part, erroneous system of zoological philosophy.

Möbius,† recognizing the necessity of revising the older conception of protoplasmic bodies (monoplastids) as invariably constituting formless automatons, has suggested that since we find evidences of organization as in some *Protozoa*, their specialized parts might appropriately be called *organula*, the diminutive of the word *organ*, as conventionally applied to cellular aggregates having special functions in the organization of the *Metazoa*.

Lamarck's laws of metamorphosis are remarkable as showing how far he had advanced beyond the conceptions of his contemporaries as to the nature of the forces at work in effecting morphological changes. Quoting again from the Introduction to the *Animaux sans Vertèbres*, edition of Deshayes and Milne-Edwards, I, p. 57, the first of these laws is stated thus:

"Life, with its peculiar forces, tends to continually augment the volume of all bodies which possess it, and to extend the dimensions of their parts, up to the end of the term of life."

This approximates the doctrine of Nägeli (*Entsteh. un Begriff der*

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* Philosophie zoologique, I, 400.

† Das Sterben der einzelligen und vielzelligen Tiere. Biolog. Centralbl., IV, 1884, pp. 389-392.

naturhistorischen Art, München, 1865) who supposes that each organism has in itself a tendency to vary in a definite direction, to increase the morphological differentiation, or, as it is commonly expressed, to perfect itself. The tendency to vary in a definite or in an indefinite direction is, however, a purely transcendental statement of what are seemingly facts. *Tendency*, as we will soon find, is a word which may be made to cover a great deal of ignorance. Tendencies must have causes. If I say that an unsupported stone has a tendency to fall, I do not tell what it is that causes it to fall; it is certainly not the tendency which makes it do so, but a specific force, which acts in such a way as to pull the earth and the stone toward each other.

Huxley* states the grounds of the divergence of opinion amongst those who accept the doctrine of evolution in its main features. Three views may be taken of the causes of variations:

"*a.* In virtue of its molecular structure, the organism may tend to vary. This variability may either be indefinite or may be limited to certain directions by intrinsic conditions. In the former case the result of the struggle for existence would be the survival of the fittest amongst an indefinite number of varieties; in the latter case it would be the survival of the fittest among a certain set of varieties, the nature and number of which would be predetermined by the molecular structure of the organism.

"*b.* The organism may have no intrinsic tendency to vary, but variation may be brought about by the influence of conditions external to it. And in this case, also, the variability induced may be either indefinite or defined by intrinsic limitation.

"*c.* The two former cases may be combined, and variation may to some extent depend upon intrinsic, and to some extent upon extrinsic, conditions.

"At present it can hardly be said that such evidence as would justify the positive adoption of any one of these views exists."

These statements of the grounds of the hypothesis of evolution by one of the greatest biological thinkers of our time are, like everything else which he writes, logical and to the point; but let us see how Lamarck had already appreciated the interaction of the above-mentioned intrinsic and extrinsic forces in his second law (*An. sans. Vert.* I, 57):

"Second law: The production of a new organ in an animal body results from a new need which has arisen unexpectedly, and which continues to make itself felt, and which causes the new movements to be made to which this need gave origin and maintained."

Totally new organs, with new functions, are, as is well known, rarely developed; but the method of evolution seems to be to seize upon an organ already developed and modify it by adding or subtracting to or from its bulk, or so modifying it as to amount to a metamorphosis of

*Anat. of Invertebrated Animals, pp. 41, 42.

the original structure. This is probably what Lamarck meant in speaking of new organs, since the doctrines of special and serial homologies were not developed in his time as they now are.

The causes or origin of variations are contemplated in this second law, as already urged, especially if we admit that the word *need* may be replaced by the term *stimulus*, as is fully justified by the closing phrases on the intrinsic or reflex actions evoked by a change in the environment. The second law thus becomes very similar in its main features to Huxley's third and provisional statement of the first principles of the doctrine of evolution, as the final alternative, with which the greatest number of evolutionists would now probably be in accord.

While we must admit, with Mivart, that the formative forces controlling the growth of the embryo from an egg seem to be automatic or instinctive, we can assert with some confidence that, in many cases at least, there is positive evidence to the effect that growth force has a determinate direction along a certain axis, and that the first cleavage plane is coincident with the direction of the median long axis of the future animal.* The study of the promorphology of the ovum, as it has been called, thus indicates that the progress of development even during its very early stages exhibits polar phenomena, which are expressed not only as an external polarity, but also as an internal one, involving the most extraordinary rhythmical metamorphosis of the prmordial egg-nucleus and its descendants, which become the nuclei of the cells into which the original germinal mass subdivides. The successive events involved in the ordinary indirect process of segmentation seem to be principally the following: 1, the aggregation of the chromatin substance of the nucleus into looped fibers which are freed from the nuclear wall; 2, the radiated arrangement of the segments of chromatin fibers, with their loops directed towards the center of the nucleus and the free ends towards its periphery; 3, the longitudinal subdivision of the chromatin fibers into more slender ones, with the same arrangement as before; 4, systole, or aggregation of the more thickened chromatin fibers about the incipient plane of cleavage, with achromatin fibers forming the poles of the nuclear spindle; 5, diastole of the chromatin fibers, which subdivide again and retreat to the nuclear poles, leaving achromatin fibers intervening between the two polar wreaths which the chromatin fibers form; 6, completed diastole of the chromatin fibers, which now break up into bead-like masses which become applied to the walls of small nucleoplasmic vesicles which are gradually formed at the extreme ends of the polar wreaths of chromatin fibers; 7, coalescence of the small vesicles lined with chromatin at either end of the spindle to form two new nuclei, which are the centers of the two new cells resulting from the division.†

* On the development of some pelagic fish eggs: preliminary notice. A. Agassiz and C. O. Whitman. Proc. Am. Acad. Arts and Sciences, XX, 1884, pp. 74, 75.

† J. Bellonci: La Caryocinèse dans la segmentation de l'œuf de l'Axolotl. Arch. Italiennes de Biologie, VII, 1884, pp. 52–57, 1 pl.

The directions of the axes of the cleavage spindles change with each cleavage and stand at nearly right angles to each other. The directions of the spindles of alternate generations of cells are therefore for sometime nearly coincident in direction.

These phenomena, when contemplated in reference to the origin of variations, are very significant; extrinsic forces which are ever active even during the earliest stages of the nascent embryo, it must occur to every one, might very readily produce an impression upon a mechanism so delicate as the one just described, where the parts can be measured only in units of length of infinitesimally small dimensions, or in terms of thousandths of a millimeter. Variations in the action of intrinsic forces during early development need therefore be exceedingly slight in order to initiate and be productive of morphological changes which would cause the adult to vary within certain limits more or less from the parent in form, because these caryokinetic processes or nuclear metamorphoses preside over the genesis of the tissues, and the order of the manifestation of these nuclear changes seems predetermined, in consequence of which the germ of an organism may in the course of development give rise to something very nearly like the parent.

Variations in temperature affect the rate of these rhythmical metamorphoses of nuclei; low temperatures generally retard them, while higher temperatures accelerate them. This correlation between the temperature of the medium in which development goes on and the vital energy of the growing ovum exhibited during caryokinetic action is very remarkable, as shown in the course of experiments by the writer on the development of the eggs of fishes.*

We are thus brought face to face with some of the forces which must initiate variations even before there are organs present which can be exercised as in the adult, but when the germ is nevertheless complex enough, as the play of internal forces sufficiently shows through the activity which they exhibit. Matter and motion are the principal factors involved; but the matter may be said to be so compounded and in such relation to the cosmos as to be recognized as alive and capable of manifesting reflex actions. That last capacity is the thing needed by the doctrine of evolution as the justification of Lamarck's second law, which may be so extended as to involve the consideration of the primary causes leading to variation of a germ *in utero* or in the ovary; a seed in the form of the ovicell or in the ovary of the plant. In this way only does it seem conceivable that the origin of early or embryonic variations can be understood.

Lamarck's third law of metamorphosis is stated thus: "The development of the organs and their strength of action are constantly in proportion to the extent or degree to which they are used." This is now a recognized axiom of the doctrine of evolution.

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*Bull. U. S. Fish Commission, I, 1881, pp. 187–190 and 335–339, Pl. XVIII.

Fourth law: "All of that which has been acquired, outlined, or changed in the organization of individuals in the course of their lives is preserved and transmitted by the process of reproduction to the offspring which came from such parentage as had experienced such alterations." This law recognizes the influence of heredity.

The influence of the use or disuse of parts is stated in effect as follows by Lamarck in *Animaux sans Vertèbres*, I, p. 60, and also in his *Philosophie zoologique* (1809):

"Want of use of an organ, arising from acquired habits, gradually impoverishes an organ, and ends in causing it to disappear.

"The frequent use of an organ, arising constantly from such habits, augments its faculties or capabilities, causing it to acquire dimensions and a power of action which it does not have in animals exercising it less."

He also speaks of *penchants*, or impulses arising from the *sentiment intèrieur* (*An. sans Vert.* I, 81), where he speaks of the efforts made by animals for their self-preservation, where the principle of the struggle for existence seems to be *dimly*, and perhaps tacitly, recognized. He alludes to the manifestation by animals of such impulses as these: "To fly from pain; to seek and seize their nourishment; to perform the sexual act when their organizations solicit them; to seek for pleasant places and prepare for themselves means favorable for their conservation; to withdraw from painful conditions and everything which constrains or incommodes them; to seek for pleasant, advantageous situations, shelter and the sun's heat during cold periods, shade and cool places during the hot season; to satisfy the need of nourishing themselves, sometimes with voracity, either from the pleasure they find therein or the unrest which arises from the want of food; to give themselves up to the enjoyment of the sexual act, or to ardently seek occasion for it when their needs provoke or solicit it; to take repose and sleep, when their other needs are satisfied."

Intelligent impulses he speaks of as impelling an animal "to chase its prey, to watch it with patience, to lay snares; to employ new and various means, according to circumstances, to satisfy each of its needs; to resort to poltroonery or cowardice when weak in consequence of an excessive fear of danger; to preserve itself from danger by means of various ruses."

Selfish impulses (*An. sans Vert.* I, p. 82) are spoken of as impelling an animal "to escape becoming the prey of others if the latter are stronger; to chase and combat other animals which approach its female, or such that covet her possession." In this last observation he recognizes the struggle for possession amongst rival males, but does not recognize the principle of sexual selection.

Finally, he says animals are impelled "to prefer above all else that which they can do to procure for themselves the enjoyment of some advantage."

It thus becomes evident that Lamarck never clearly recognized the principle of natural selection which it has been the great merit of Darwin and Wallace to discover and announce simultaneously, yet the father of the doctrine of transmutation of species seems to have had some sort of dim conception of the fact of the reality of a "struggle for existence," as implied in his remarks on rivalry amongst males, and when he implies that animals do things the purpose of which is to gain some advantage.

The frequently quoted instance of the long neck of the Giraffe, which Lamarck thought had been produced by the persistent efforts to feed upon the foliage of trees by successive generations of the animal, has made abundance of sport for superficial writers since his time. But let us look into this matter a little more closely, and see if natural selection is at all likely to have originated longer cervical vertebræ in this creature. Granting that the external conditions were such as to favor the survival of long-necked forms, the most that natural selection could do would have been to *preserve* the long-necked individuals to reproduce the species; it could *originate* no progressive morphological differentiation, but merely be the means of preventing the extinction of the acquired increments of that differentiation.

If Palæontology is of any value as throwing any light upon the history of the evolution of the Giraffe, we probably have in *Sivatherium*, *Bramatherium*, and *Helladotherium* forms which were antecedent in time. The latter, especially, had a pretty long neck, and seems to have been higher at the shoulders than at the rump, somewhat as in the Giraffe. Here we have a probable stage of evolution of *Camelopardalis*, or a survival of a form tending in that direction, but with a neck proportionally no longer than *Camelus*, which is also allied. Now let us soberly ask ourselves if it is likely that the effort to reach for herbage, if persisted in on grassless plains, where the only food was the foliage of trees, would not tend to cause the animal to lift its head and already long neck, strengthen the ligamentum nuchæ and cervical muscles, and in pulling or wrenching off this foliage stretch its neck more and more, generation after generation, each of which would thus gain an inherited advantage in obtaining food over the one which had preceded it in time. Manifestly there must have been causes for this variation in one direction which would lead to an increased growth in length of the centrum of each cervical vertebra. Variation would have had to constantly tend in the one direction through a great many generations, which is in the highest degree unlikely, if no adequate cause existed to determine that direction. Darwin himself never lost sight of this difficulty, but his followers have frequently expressed themselves as if variation itself and natural selection were forces irrelative to the intrinsic forces exhibited by living bodies; for neither natural selection nor variation could produce any effects whatsoever if the environment were constantly the same about a living individualized entity without rivals, any more than

we would look for a moving body to ever swerve from traversing space in a right line if it were forever exempt from all disturbing resistances and attractions along its path. Dr. Tomes, in his work on Dental Anatomy, second edition, finds it inconceivable that intrinsic forces are capable of modifying the forms of the crowns of the teeth of Ungulates, apparently unmindful of the fact cited by the writer that an inorganic crystalline body as brittle as marble could be permanently bent if subjected to a constant bending strain for many years. This, however, is only one instance among many where biological writers have ignored the logic of facts when dealing with the principles of the theory of evolution.

In recently glancing over the *Philosophie zoologique* the writer finds that Lamarck had in that work briefly recorded his views on digital reduction, assigning increased use in running as a cause, as asserted by Cope, Marsh, and the writer in later times. Some years since the writer attempted to discuss digital reduction, when it "was suggested that the fact of the number of toes being least wherever *mechanical strains* were greatest and *impacts* most frequent and severe, might be regarded as an effect of such increased intensity of strains." Cope afterwards showed that the grooving of the articular faces of the limb-bones of certain *Mammalia* was probably due in part to such a cause. The writer also called attention to the coexistence of accelerated digital reduction in the pes with jumping or bounding habits, in consequence of which the reduction began first in the hind limbs; pointing out, also, in this connection, that man, the highest and only strictly bipedal primate, is the only one in which a perceptible digital reduction has begun in the pes, so as to enlarge the inner toe.

The specialization of the limbs of the modern Sloths has also been discussed by Lamarck, who assigns their peculiar habits as the cause of certain modifications of the limbs and other portions of the skeleton. The writer, unaware at that time of Lamarck's published views, had prepared an essay upon the same subject, in which he has given expression to certain views which were already expressed by the earlier author; but inasmuch as the writer had also discussed the digital and dental reduction which occurs in this group, including the fossil species, it has been decided to hand the manuscript to a palæontological friend competent to revise and bring it up to date for publication at an early date.

It has been thought proper to make these acknowledgments to one of the most far-sighted intellects that has ever honored the pursuit of biological investigation, for the reason that many of the students of to-day seem forgetful of the man to whom indirectly they owe so much. The writer also would acknowledge his indebtedness to this pioneer evolutionist, and would frankly admit that Lamarck was the first to perceive that morphological changes were traceable to the action of forces, the effects of which we have been seeking to follow in this study of the evolution or morphological differentiation of the fin-systems of the *Lyrifera*.

XVII.—A STATEMENT OF SOME OBJECTIONS AND CONCLUDING REMARKS.

I am aware that it may be objected that the development of an opisthure in *Chimæra monstrosa*, while it is absent in *C. plumbea*, would seem to militate a good deal against the hypothesis here set forth, since it might be asked why the same forces should not produce the same effects in both these forms otherwise so nearly allied. Nor is this the only objection which might be raised, for why is it, it may be inquired, that certain physostomous forms, as *Alosa* for example (which is evidently lower in respect to the development of the air-bladder than the *Physoclisti*), should exhibit a specialization of caudal development not found to occur in those forms which are evidently more advanced when their entire organizations are considered in this comparison? But none of these or the numerous kindred objections which might be raised need dismay us in our inquiry for the reason for the present morphological composition of the caudal fins of fishes, in which we have been at least measurably successful in demonstrating something akin to order in the elucidation of the most important of all the questions relating thereto, namely, that the skeletal parts are, beyond any doubt whatever, serially homologous. When once this fact is appreciated, and it is at the same time understood that the skeletogenous layers are also homologous throughout the different groups of fishes, it will be evident to any reasonable person that the causes which would lead to the production of very different morphological effects would need but little modification to make them effective. This is all the more evident when it is remembered that the habits of the different groups vary very greatly, and that the special modification of some part through the exercise of some special habit must affect other parts correlatively, so that it becomes impossible to predict what the effect will be upon the many parts taken singly in such a complex aggregate. It is now at least self-evident that the possibility of *chance variations* having anything to do with determining the mode of evolution of the tail of fishes is in the highest degree improbable. Extreme reduction and degeneration in certain directions have also been clearly shown to occur, the evidence on this point being too palpable and conclusive to admit of dispute.

Not less weighty than the objection urged in the case of the *Holocephali* is that which might be urged in the case of *Caturus* and *Leptolepis*, Liassic and Oolitic forms, almost as outwardly homocercal and structurally almost as heterocercal as the most differentiated existing Teleosts. Why is it, it might be inquired, that these forms have reached heterocercal and outwardly homocercal specialization so soon? Or why should the archaic or primitive diphycercal type be preserved in the existing *Dipnoi* if these and their kindred have been subject to the same outward mechanical forces as the line which ended in the production of the extreme heterocercy of the Teleosts? Have the *Dipnoi*, however, developed

such an inequality in the relative width of the unpaired epural and hypural fin system as could lead to the production of heterocercy? We see that such inequality has not arisen and that perfect diphycercy has been maintained in the *Dipnoi*, from which it follows that it is safe to assert that there must have been some difference between the forces which acted upon the ancestry of the latter and that of the existing *Teleostei*. In this way only can we conceive archaic characters to have been preserved and handed down to the present.

Huxley's statement,* that "in all Teleostean fishes the extremity of the spinal column bends up, and a far greater number of the caudal fin-rays lie below than above it," must now be qualified so far as to admit that in some Teleosts there is no such upbending of the end of the axial skeleton, as in *Mola*, *Fierasfer*, and *Gastrostomus*, for example; nor is it invariably true that a greater number of fin-rays lie below than above the termination of the axial skeleton. The result of these investigations has accordingly been to modify somewhat the accepted views of the evolution of the caudal fin from a prototype which was essentially *orthaxial* posteriorly, or one in which the posterior terminus of the axial skeleton was straight and in line with the thoracic portion.

The parallelism existing between the tails of the orthaxial lophocercal larvæ of existing fishes and the orthaxial caudal of *Cœlacanthus*, *Coccosteus*, *Glyptolæmus*, and *Gyroptychius* is not exact, because these extinct forms had more or less clearly marked rays or apophyses developed. *Coccosteus* seems to have had no caudal fin, but had apophyses developed above and below its notochordal axis posteriorly, thus attaining a specialization almost as marked in this respect as that observed in the existing genus *Hippocampus*. These are facts which must not be lost sight of, for we may assume that the development of a form recapitulates the development of the phylum to which it belongs, when in fact it does so very inexactly, as the examples above cited show. Another illustration may be cited, viz, that of the protopterygian stage of the Salmon embryo when its embryonic rays, cartilaginous apophyses, and notochord recall the permanent condition found in the *Dipnoi*. But in the Salmon embryo we find has no perichondrial ossifications developed at this time about the epaxial and hypaxial apophyses of its axial skeleton, as in the *Dipnoi*, nor is the end of the chorda any longer orthaxial at its termination, as in the latter.

These accelerated departures from the primitive type are evidently dependent for their manifestation upon heredity, since structures characteristic of classes, orders, families, genera, and species seem to appear in most embryos in about the order of rank in which they stand above, though in many cases so pronounced is the direct influence of heredity that a family or, at most, an ordinal, character will appear at the end of the first day, as in the case of the development of the barbels of *Amiurus*.

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* Anat. of Vertebrated Animals, p. 131.

These data might be used as objections to the conclusions reached in this paper, were it not that we have the most conclusive grounds for believing that the morphological differentiations or metamorphoses, so rapidly passed over during the embryonic stages of many vertebrated organisms, are the transitory expression of characters acquired during the adult life of ancestral series, extending back into long ages past. The embryo has obviously not had time during its brief career of development to acquire the differentiations which we note in the adult. Many embryonic traits are also the necessary complements of a mode of development which is characteristic of all Vertebrates, namely, their evolution from a spherical, more or less meroblastic egg. We may therefore, I think it probable, look upon almost every character above classical value as acquired by a type during the post-larval history of the individuals constituting its ancestral series; and inasmuch as natural selection cannot be looked upon as an originative force, but only as a conservative law or principle, we are forced to conclude that advantageous variations must have arisen as the direct results of the interaction and retroaction constantly going on between an organism and its environment.

EXPLANATION OF PLATE I.

FIG. 1. Male of *Chimæra monstrosa*, reduced from a figure in Agassiz's *Poissons Fossile*, showing the opisthural filament.

FIG. 2. Side view of embryo ray in the lophocercal stage, showing its attachment to the yelk-sack by the hollow vitelline stalk which opens into an ellipsoidal depressed cavity on the yelk, shown in outline. Vessels of one side of the yelk only are indicated. Natural size, from a specimen taken near Wood's Holl, Mass., in 1883.

FIG. 3. Lophocercal tail of young flounder 6 mm. long.

FIG. 4. Lophocercal tail of young flounder a little older than the preceding, beginning to show a slight upbending of the notochord, and the first trace of the permanent caudal lobe *pc* and opisthural lobe *op*.

FIG. 5. Indentation appearing in the caudal lobe of a somewhat older flounder, permanent fin-rays being defined.

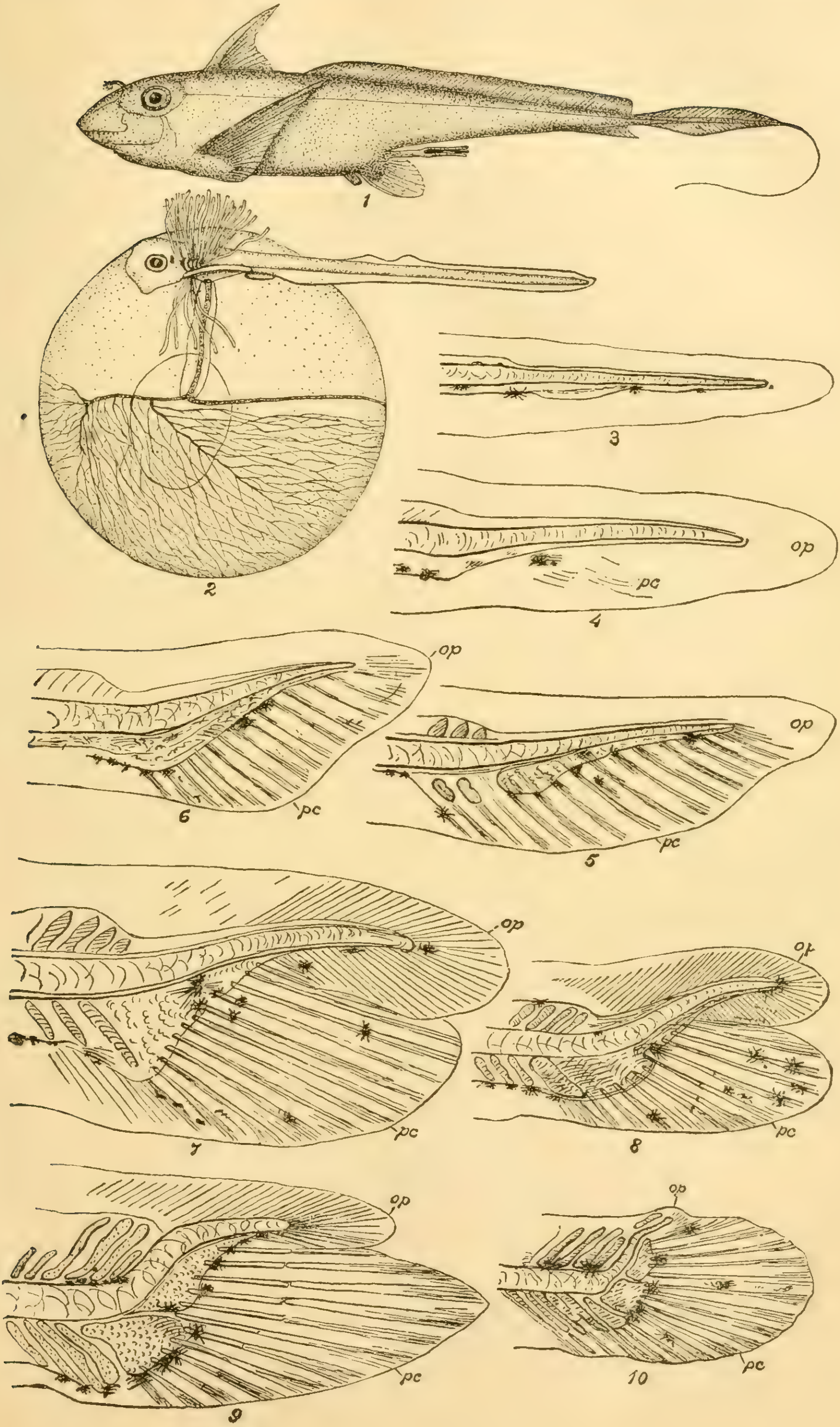
FIG. 6. Tip of notochord still more flexed upward than in the preceding; permanent caudal and opisthural lobes somewhat more distinct.

FIG. 7. Permanent *pc* and opisthural lobes *op* now form a sharp angle where they join; distinction between permanent and embryonic rays well marked.

FIG. 8. Permanent caudal as long as opisthural lobe *op*.

FIG. 9. Cartilaginous supports of fin-rays are now strongly developed; the end of the chorda has begun to degenerate and approximate the position which it will occupy permanently as the urostyle.

FIG. 10. The caudal has become more rounded, the opisthure *op* is almost wholly absorbed and the notochord has suffered atrophy somewhat, and now presents a still closer approximation to the form of the urostyle of the adult. Figs. 3 to 10, inclusive, after A. Agassiz.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EXPLANATION OF PLATE II.

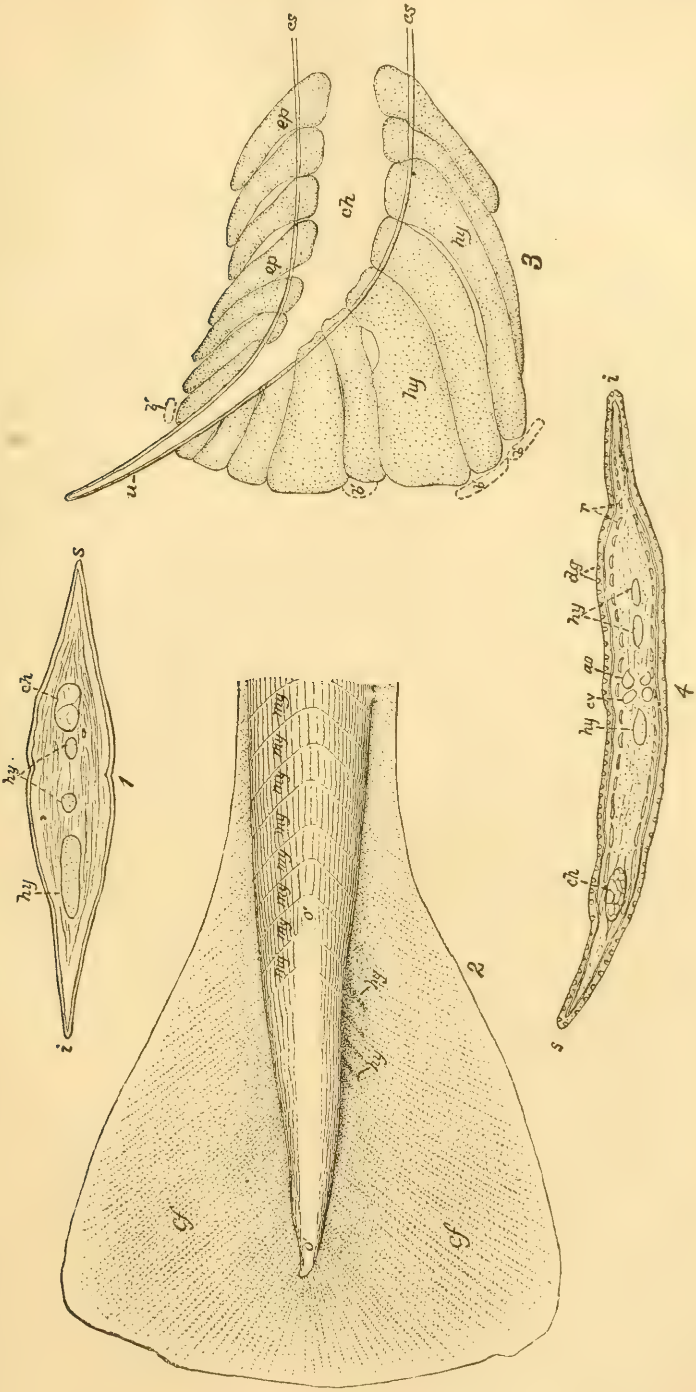
FIG. 1. Vertical section of the tail of *Alosa sapidissima* 22 days old; *s* superior, *i* inferior border, *hy* hypural cartilages, *ch* chorda surrounded by connective and muscular mesoblastic tissue. x 65.

FIG. 2. Tail of *Alosa sapidissima* 4 days after hatching, showing the striate caudal fold *cf*. The direction of the striæ correspond to the direction in which growth has manifested itself, and seems to be an effect of the development of the embryonic rays. The myotomes *my* are shown to be faintly developed almost to the end of the tail, but there is a space on the side from *o* to *o'* where muscular tissue has degenerated and is not present, so that the voluminous chorda lies in immediate contact with the skin at this point. The hypural elements are just forming and are shown to be related to corresponding somites; their bases have pushed the ventral wall of the chorda inward slightly. From a balsam preparation. x 64.

FIG. 3. Epural and hypural cartilages of the tail of the California salmon, *Oncorhynchus*, with the accessory basilar pieces *b'* in outline; these are developed later. x 32. From a specimen cleaned in a 5 per cent. potash solution and rendered transparent with glycerine.

FIG. 4. Vertical section through the tail of an advanced embryo land-locked salmon; *s* superior, *i* the inferior margin, *hy* hypural pieces, *ch* end of chorda, *cv* caudal vein, *ao* aorta, *r* rays cut across and composed of homogeneous material, *dg* unicellular dermal glands, or goblet cells. The permanent rays *r* are cut across at their proximal ends, and it is evident that they are imbedded in mesoblast. x 32.

PLATE II.



EXPLANATION OF PLATE III.

FIG. 1. Tail of the embryo of *Salmo salar*, with two hypural chondrifications in process of formation, on the first day after hatching. Circa x 30. Slightly modified from Lotz.

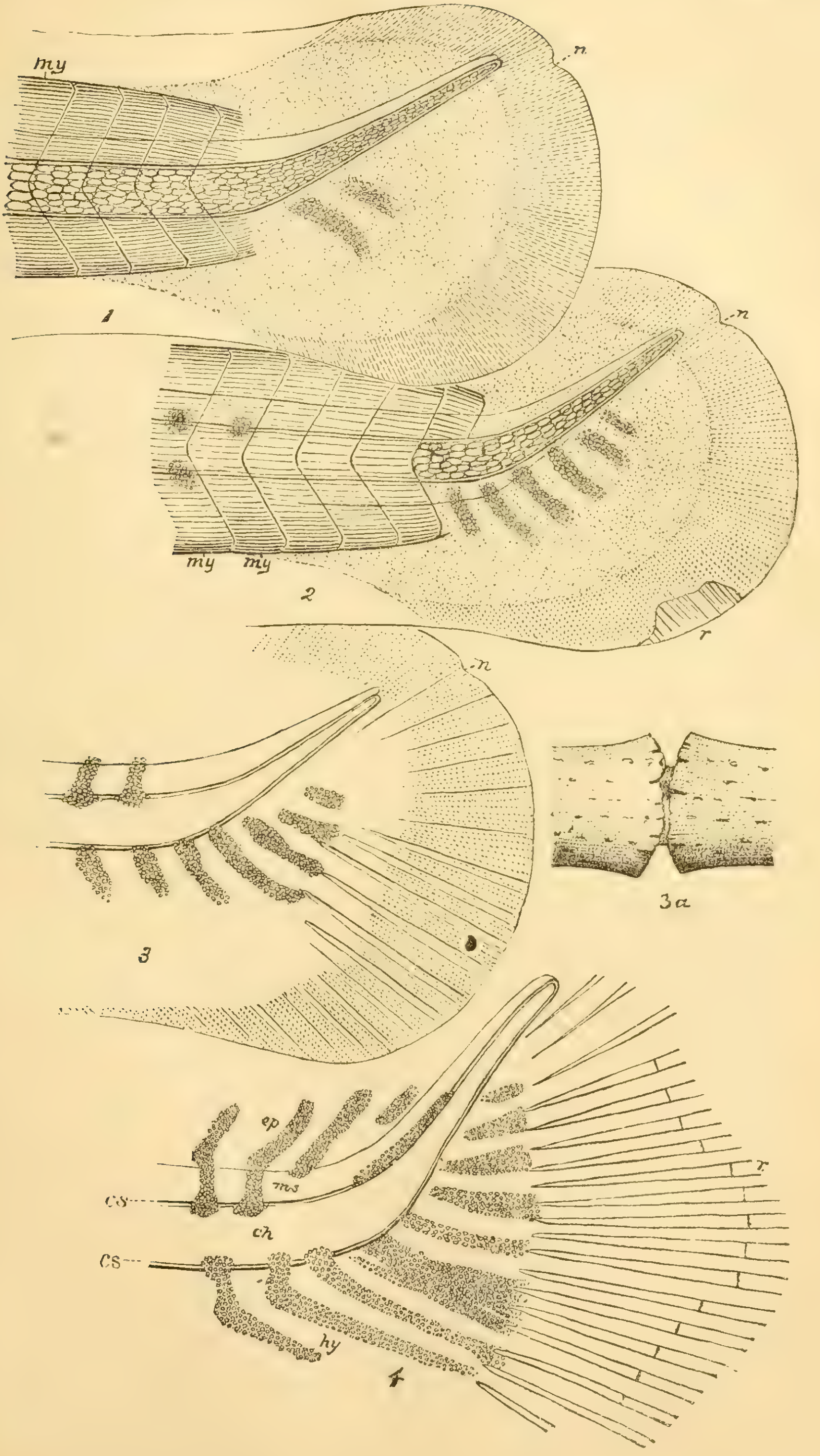
FIG. 2. Tail of a somewhat older embryo of the same, with six hypural chondrifications in the process of formation, with embryonic rays at *r* uncovered at the edge of the caudal fold, on the sixth to seventh day. From the same. x 30.

FIG. 3. Tail of a still older salmon embryo, with seven hypural and two epural chondrifications being developed, and with the caudal rays more developed and approaching the hypural elements, on the tenth to twelfth day. From the same. x 30.

FIG. 3*a*. Magnified view of one of the joints of an ossified fin-ray from a young salmon. x 300. After Lotz.

FIG. 4. Tail of a more advanced embryo, showing the principal caudal rays segmented and in contact proximally with the free end of the hypural pieces, of which there are ten, two of them having coalesced, while there are five epural pieces represented by cartilaginous aggregations, two of which are in contact with the chorda, and three in the position of "false spines," the last two being rudiments around which the *Deck-knochen* ossify, on about the twenty-fourth day. x 30. From the same.

n, caudal notch dividing secondary caudal lobe from the tip of the primordial larval tail; *ms*, medulla spinalis; *hy*, hypural pieces; *ep*, epural pieces; *r*, rays; *ch*, chorda; *cs*, chorda sheath; *my*, myotomes = muscular somites < proto-vertebræ. (For the details of the development of the rays see Plates IX and X.)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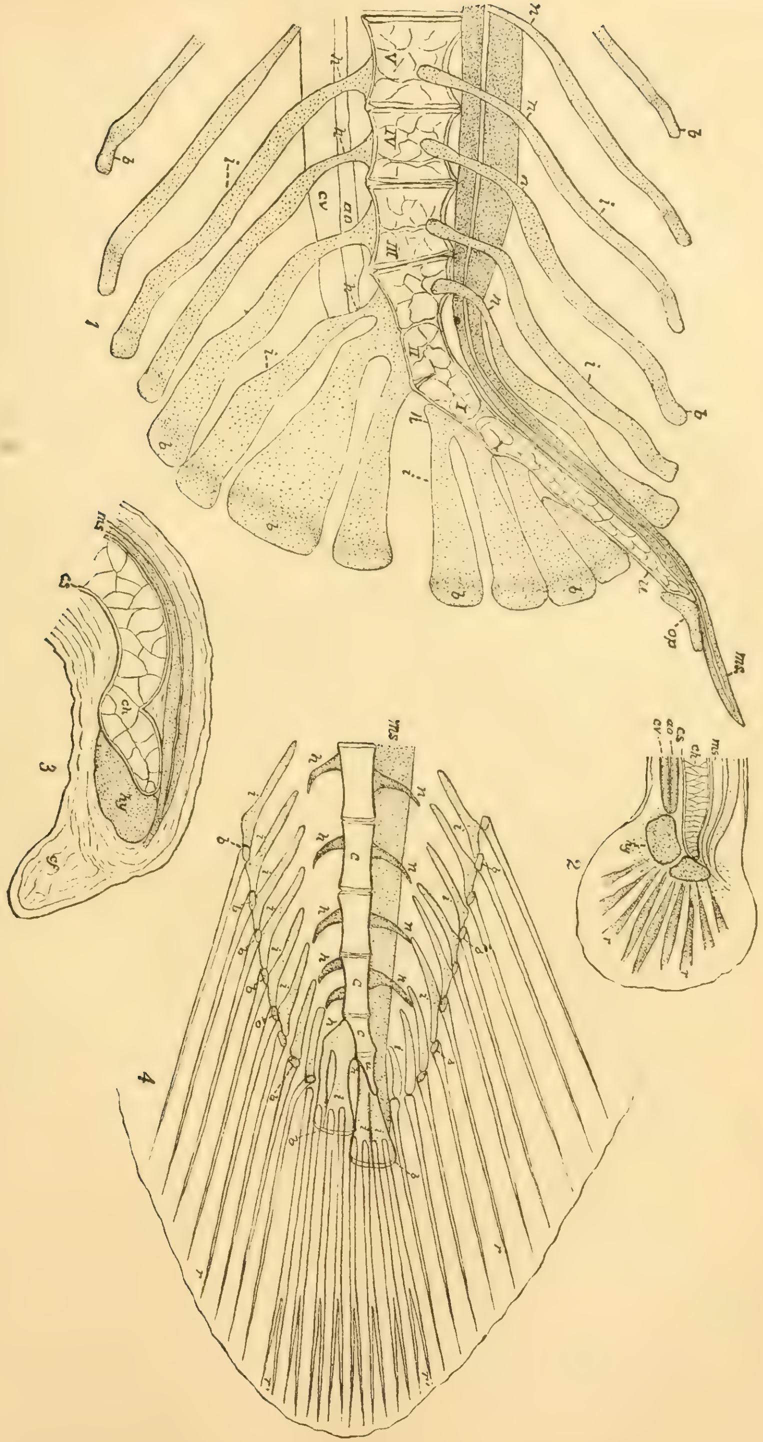
EXPLANATION OF PLATE IV.

FIG. 1. Caudal skeleton of *Amiurus albidus*, from an embryo fifteen days old; rays not represented; the vertebræ V, IV, III, clearly marked, II and I subsequently become fused and continuous with the urostyle *u*. The cartilaginous epural and hypural pieces consist of neural spines *n*, coalesced with interneural elements *i* and basilar epiphysial elements or actinophores *b*; *ao* and *cv*, aorta and caudal vein embraced by the hæmal arches *h*. Medulla spinalis *ms* embraced by the neural arches *n*, but degenerate posteriorly and exserted beyond the urostyle, and resting partly on the opisthural cartilage *op*. x 64. From a chromic acid specimen which was sectionized and the outlines of the elements superimposed with the camera-lucida.

FIG. 2. Tail of an embryo of *Siphostoma*, showing the rudimentary hypural pieces, evidently comprising several coalesced elements, as is shown by the number of rays *r*. x 96. From a transparent specimen mounted in balsam. The upward deflection of the end of the medulla spinalis *ms* is also indicated.

FIG. 3. Tail of a very young *Hippocampus antiquorum*, x 183, showing a very rudimentary caudal fold *cf*, and a trace of the hypural cartilage *hy*, which is partly opisthural or post-chordal.

FIG. 4. Tail of a very young *Anguilla* two and one-third inches long, in the cœlacanthous stage of development, but with the interspinous elements nearly entirely cartilaginous. *i*, interspinous elements; *h*, hæmal arches; *b*, basilar cartilages, all discrete except the four hypural elements, which are reduced by concrescence to two in the adult. The rays from r' to r' are dichotomous, and belong to the caudal proper, while the rays *r* are dorsal and anal. Some epural interspinous pieces are aborted, and the last vertebra *u* is pointed posteriorly, and represents the urostyle. The last four hypural processes bear two caudal rays each, thus indicating that they each represent two coalesced basilar and interspinous elements, since there are two successive systems of interspinous and basilar elements to each vertebra anterior to the two true caudal segments. The urostyle has therefore degenerated and shortened so that proximal concrescence of the median appendicular skeleton bearing the eight caudal rays has occurred. The last three vertebræ *c c u* are ventrally two-spined, the last two four-spined, if their hypural elements are considered to be double. The last two caudal centra are spineless dorsally. x 32.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EXPLANATION OF PLATE V.

FIG. 1. Caudal skeleton of *Coccosteus*, after Pander; *ep* and *hy*, epural and hypural elements, all of which do not bear rays, but, as in Pterichthys, extended out only as far as the scaly covering of the tail; *d* dorsal, *a* anal fins.

FIG. 2. Caudal skeleton of *Polypterus*, from Agassiz's *Poissons Fossile*, modified after Kölliker; *ep'*, styliform ray-bearing and nodular non-ray-bearing interspinous epural elements; *ep*, neural spines; *hy*, hypural ray-bearing elements.

FIG. 3. Caudal skeleton of adult *Lepidosteus*, from Kölliker, showing the urochord more prolonged and attenuated than in the preceding.

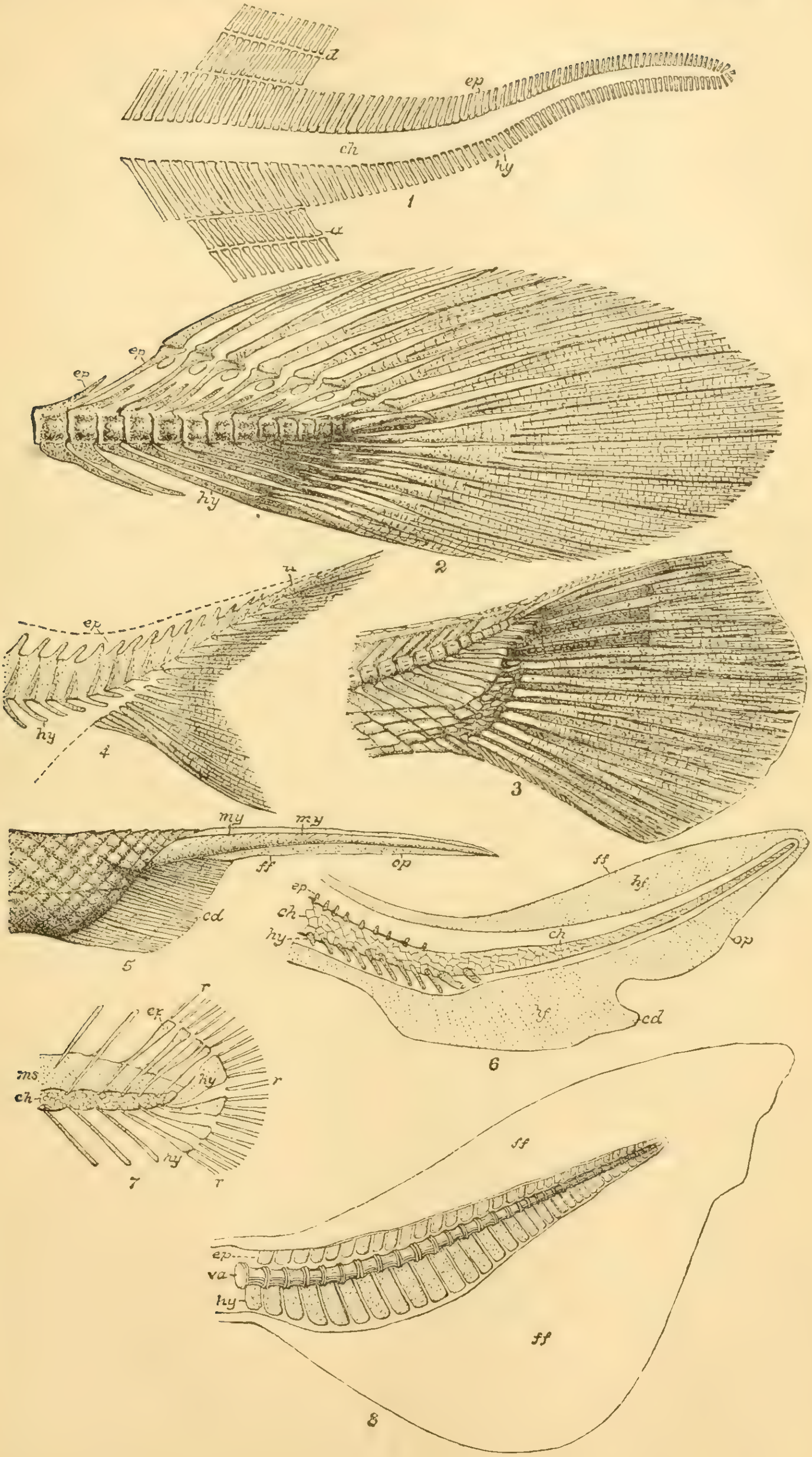
FIG. 4. Caudal fin of *Platysomus* as restored by Agassiz in the *Poissons Fossile; ep* and *hy*, epural and hypural pieces; *u*, urochordal end of the skeletal axis, which was mainly notochordal.

FIG. 5. Tail of a young specimen of *Lepidosteus*, 11 centimeters long, from Balfour and Parker; *cd*, permanent caudal; *ff*, eradiate fin-fold of opisthure; *op*, opisthure; *my*, *my*, its myotomes.

FIG. 6. Side view of the tail of a larva of *Lepidosteus*, 21 millimeters long, dissected and magnified so as to show its structure at this stage; *ep* and *hy*, epural and hypural cartilaginous rudiments of the neural and hæmal arches; *ch*, chorda; *ch*, its opisthural portion, which afterwards becomes partially aborted and included in the upper part of the tail; *cd*, tip of fold, which becomes the permanent caudal; *op*, opisthural lobe of the larval tail; *ff*, lophocercal fin-fold, which contains horn-fibers *hf* throughout its extent. After Balfour and Parker.

FIG. 7. Magnified view of the caudal skeleton of a young Cyprinodont (*Gambusia*), $\frac{1}{3}$ of an inch long, and which was removed from the ovarian follicle in which it developed; *ch*, chorda; *ep* and *hy*, epural and hypural cartilages; *ms*, medulla spinalis; *r r r*, rays.

FIG. 8. Caudal skeleton of *Centrina salviani; ep* and *hy* as before; *va*, vertebral axis; *ff*, *ff*, its dorsal and ventral membranous lobes, which include numerous horny and partly osseous supporting fibers. From Günther.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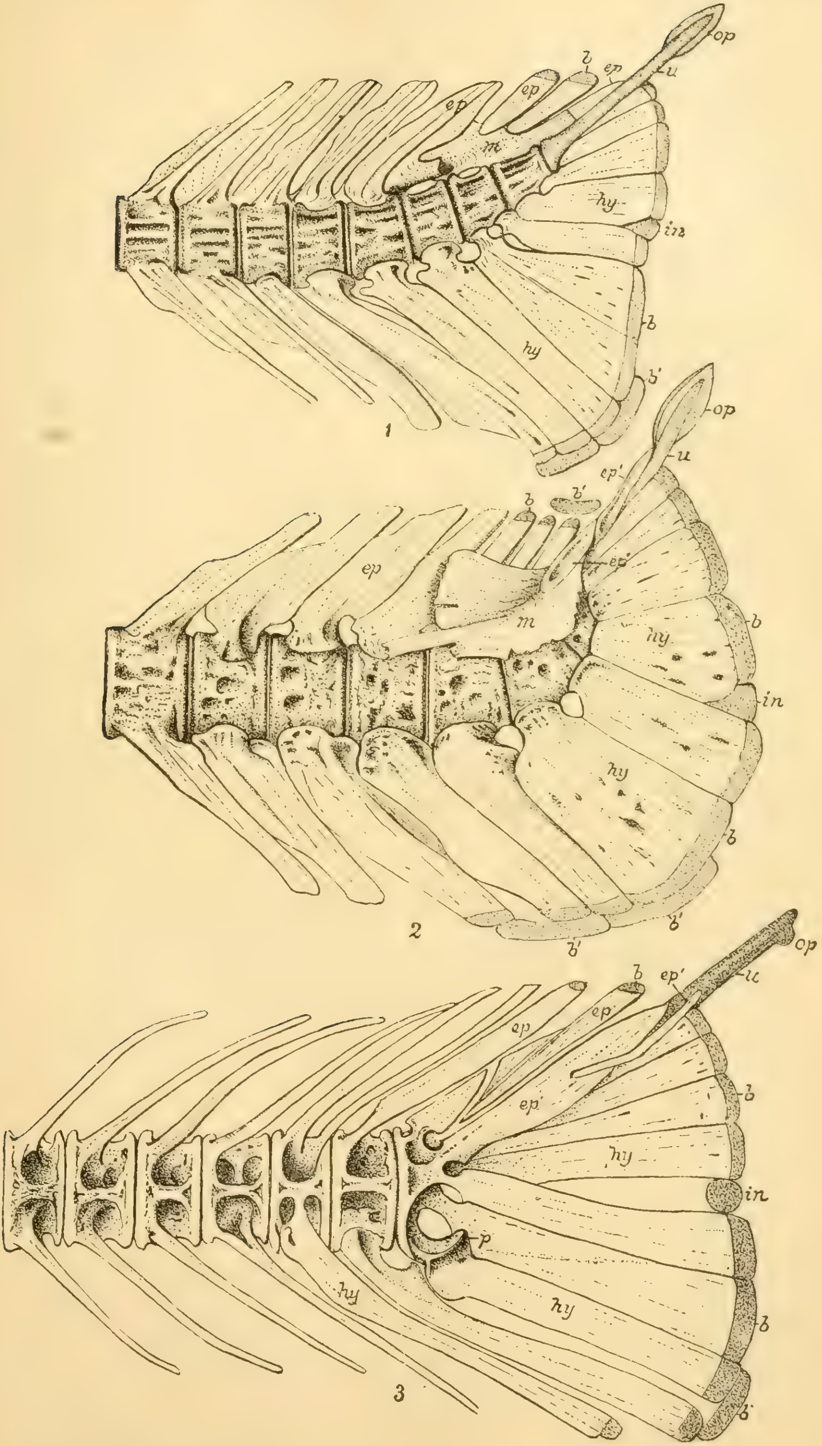
EXPLANATION OF PLATE VI.

FIG. 1. Caudal skeleton of *Salmo fario; b* and *b′*, basilar cartilages or actinophores ; *ep*, epural ; *hy*, hypural elements ; *m*, lateral membrane bone, which has had an epural cartilaginous element as its nucleus ; *in*, intercalary cartilage ; *u*, urostyle ; *op*, opisthural element. X 3. After Lotz.

FIG. 2. Caudal skeleton of *Salmo salar; ep*, epural elements ; *ep′*, laterally displaced epural elements, from which the membrane bone *m* has extended in perichondrium ; *b* and *b′*, basilar cartilages or actinophores ; *in*, intercalary cartilages ; *hy*, hypural bones ; *u*, urostyle ; *op*, opisthural rudiment, nat. size. After Lotz.

FIG. 3. Caudal skeleton of *Barbus fluviatilis ; ep*, epural, and *ep′*, laterally displaced epural bones ; *hy*, hypural bones ; *in*, intercalary cartilages ; *b* and *b′*, basilar cartilages or actinophores; *p*, lateral tuberosity for the attachment of the caudal muscles ; *u*, urostyle ; *op*, hypaxial opisthural rudiment. X 2. After Lotz.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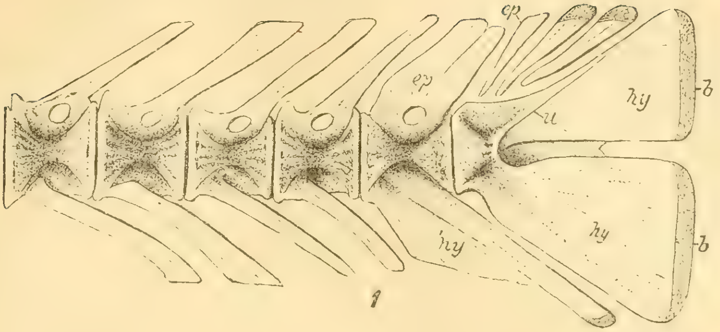
EXPLANATION OF PLATE VII.

FIG. 1. Caudal skeleton of *Cottus gobio; b*, actinophores or basilar interneural cartilages; *ep*, epural; *hy*, hypural elements; *u*, urostyle. x 8. From Lotz.

FIG. 2. Caudal skeleton of *Perca fluviatilis; ep*, epural, *hy*, hypural elements; *b*, basilar cartilages or actinophores; *u*, urostyle; *in*, intercalary cartilages. x 3. From Lotz.

FIG. 3. Gephyrocercal caudal extremity of *Echiodon dentatus; c*, centra; *ep*, epural; *hy*, hypural processes; *i*, interspinous cartilages; *h*, hiatus between dorsal rays *rd* and post-anal rays *rv*. x 17. After Emery.

FIG. 4. Caudal extremity of *Fierasfer acus; ep*, epural processes; *c c c*, centra not in contact; *ch ch ch*, membranous or cartilaginous intercentral intervals; *uch*, exserted end of chorda or urochord; *h*, hiatus between last dorsal rays *rd* and last post-anal rays *rv*. x 55. After Emery.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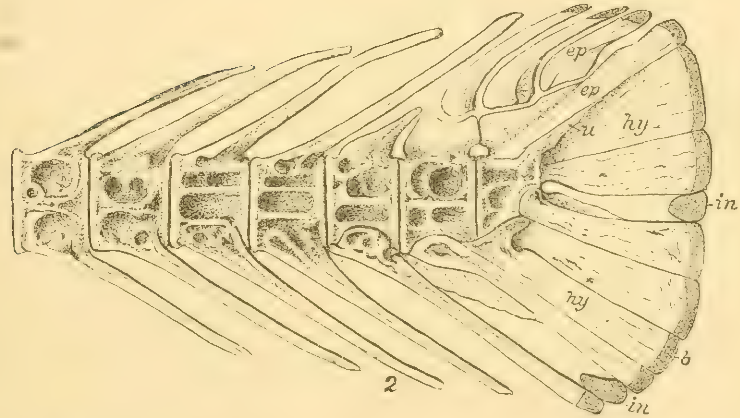
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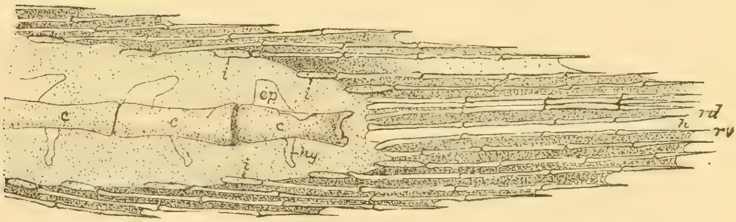
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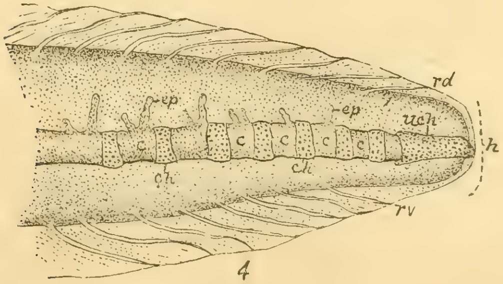
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EXPLANATION OF PLATE VIII.

FIG. 1. Youngest stage of development referred to *Mola*, and known as *Ostracion boops* (from a drawing by Sir J. D. Hooker, published by Richardson), supposed to be enlarged.

FIG. 2. *Molacanthus* stage of *Mola*. From Günther.

FIG. 3. *Molacanthus* stage of *Mola*. Slightly altered from a MS. figure by F. W. Putnam.

FIG. 3*a*. Caudal vertebræ of *Molacanthus*, together with their spines and musculature exposed, showing rudimentary rays and what seem to be traces of caudal interspinous elements, drawn from a specimen in the U. S. National Museum, somewhat enlarged.

FIG. 4. A young specimen of *Mola* some time after it has passed the *Molacanthus* condition, with the dermal spines still in place. (A spine which is found just below the pectoral seems not to be represented.) From Günther.

FIG. 5. A young *Mola*, showing the scars where the dermal spines of the *Molacanthus* stage have dropped off, and with the median ray-bearing projection from the center of the caudal represented. (The caudal has been represented as somewhat wider than in the alcoholic specimens, which seem to have been somewhat shrunken.) From specimens in the U. S. National Museum.

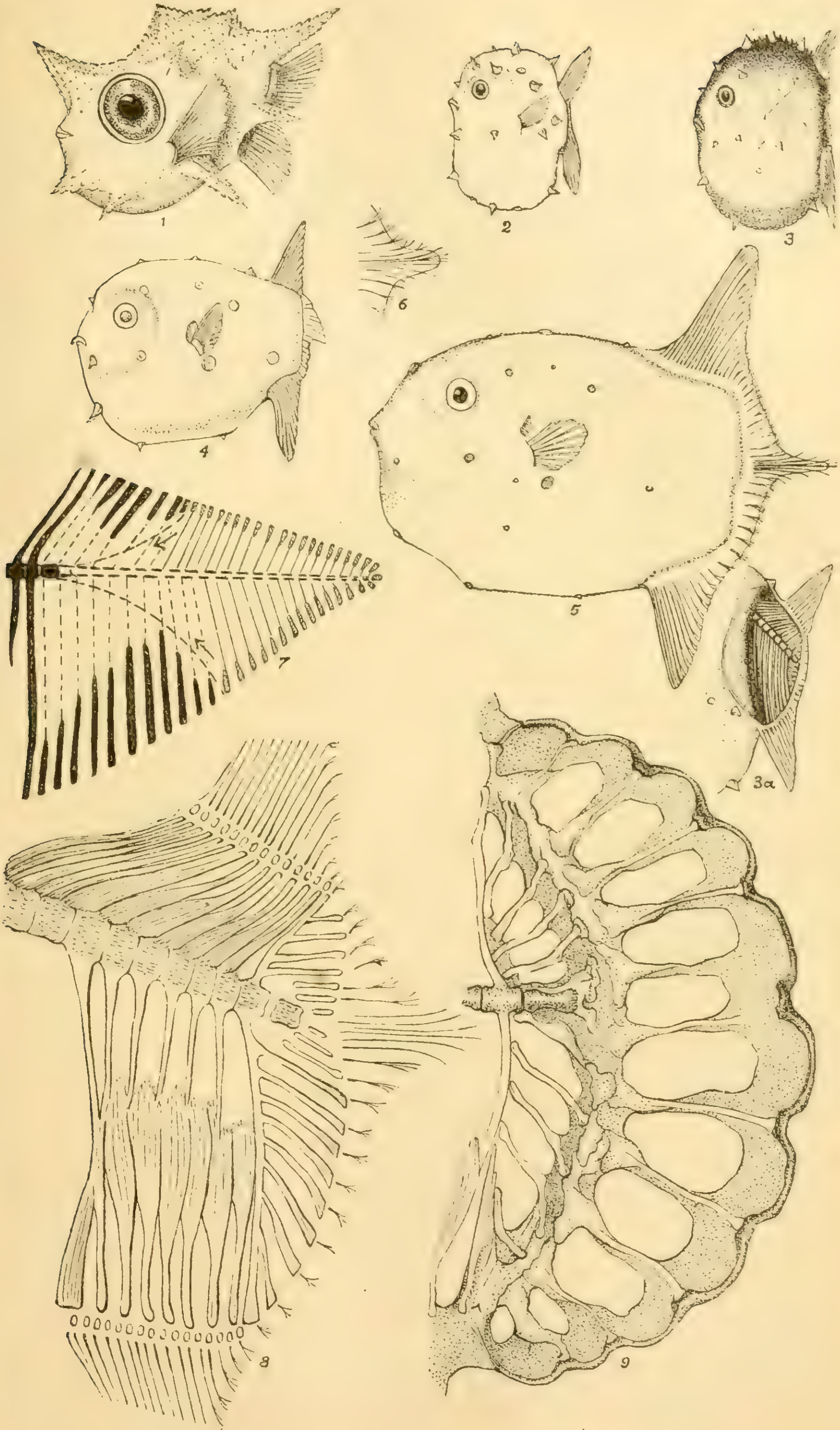
FIG. 6. Median caudal projection of a somewhat older specimen than the preceding, showing the rays to be composed of fused horny fibers at this time.

FIG. 7. A diagram intended to show the parts which have been lost in the caudal skeleton of *Mola*. The black interspinous elements are supposed to be swung forward against the neural and hæmal spines of the sixteenth vertebræ. The end of the chorda in dotted outline, and the shaded interspinous pieces, with their corresponding segments, are supposed to have been aborted.

FIG. 8. Caudal skeleton and part of the muscles of the young of Mola in the condition of Fig. 5, somewhat altered from a MS. figure by F. W. Putnam, in order to show the dichotomous caudal rays, which seem to become partially aborted in the central portion as the animal becomes adult, and to undergo other retrogressive changes.

FIG. 9. A reduced figure of the caudal skeleton of an adult of *Mola rotunda*, which shows that the median interspinous elements become coössified, while the ends of the rays become hidden or more thickly covered by the integument. This figure illustrates the most extremely modified example of the gephyrocercal tail. From Wellenbergh.

PLATE VIII.



EXPLANATION OF PLATE IX.

FIG. 1. Tail of a recently-hatched salmon embryo, x 16; *ep* and *hy*, epural and hypural cartilages; *ch*, chorda; *ms*, tip of medulla spinalis; *my my*, myotomes (partially aborted and transformed into the caudal muscles posteriorly); *cn*, notch between opisthural and permanent caudal lobe; *hf hf*, horny fibers from which the permanent rays *r r r* are partially formed.

FIG. 2. Insertion of the vibratores spinæ or lateral muscles of the anal fin of a young salmon into the basal sheet in which the horny fibers *hf* end. x 183.

FIG. 3. Part of the tip of the tail and tail-fold of a young codfish, ten days old, to show the development of the horny fibers *hf* from the fusiform cells or pterygoblasts *pt*; *ch*, chorda; *ms*, medulla spinalis; *mtf*, posterior margin of tail-fold. x 365.

FIG. 4. Diagram from a vertical transverse section through the basal part of the caudal lobe of a young salmon recently hatched, to show the permanent rays *pr* in section, and the horny fibers *hf*, both being invested by the mesoblast *mes*; *ep*, epiblast or larval skin. x 96.

FIG. 5. Diagram from a section still nearer the base of the caudal of a young salmon of the same age, showing three hypural cartilages *hy* cut across. x 96.

FIG. 6. Diagram from a section through the tail of a young salmon, nearer the margin of the caudal than Fig. 4; *v v*, vessels; *mes*, mesoblast; *pr*, permanent fin-rays, cut across; *pr'*, showing traces of the way in which the horny fibers *hf* become invested by a homogeneous material and fused together. x 183.

FIG. 7. A diagram from a portion of the caudal fold still nearer its margin than that shown in Fig. 6; *g*, unicellular goblet cells of the epithelial layer *ep* of the epiblast; *mp*, Malpighian layer of the skin; *pr*, homogeneous rudiments of the permanent rays between the epiblast and mesoblast, the latter being thickened between the rudimentary halves of the permanent rays of opposite sides; *v v*, vessels; *hf*, horny fibers; *mes*, mesoblast. x 183.

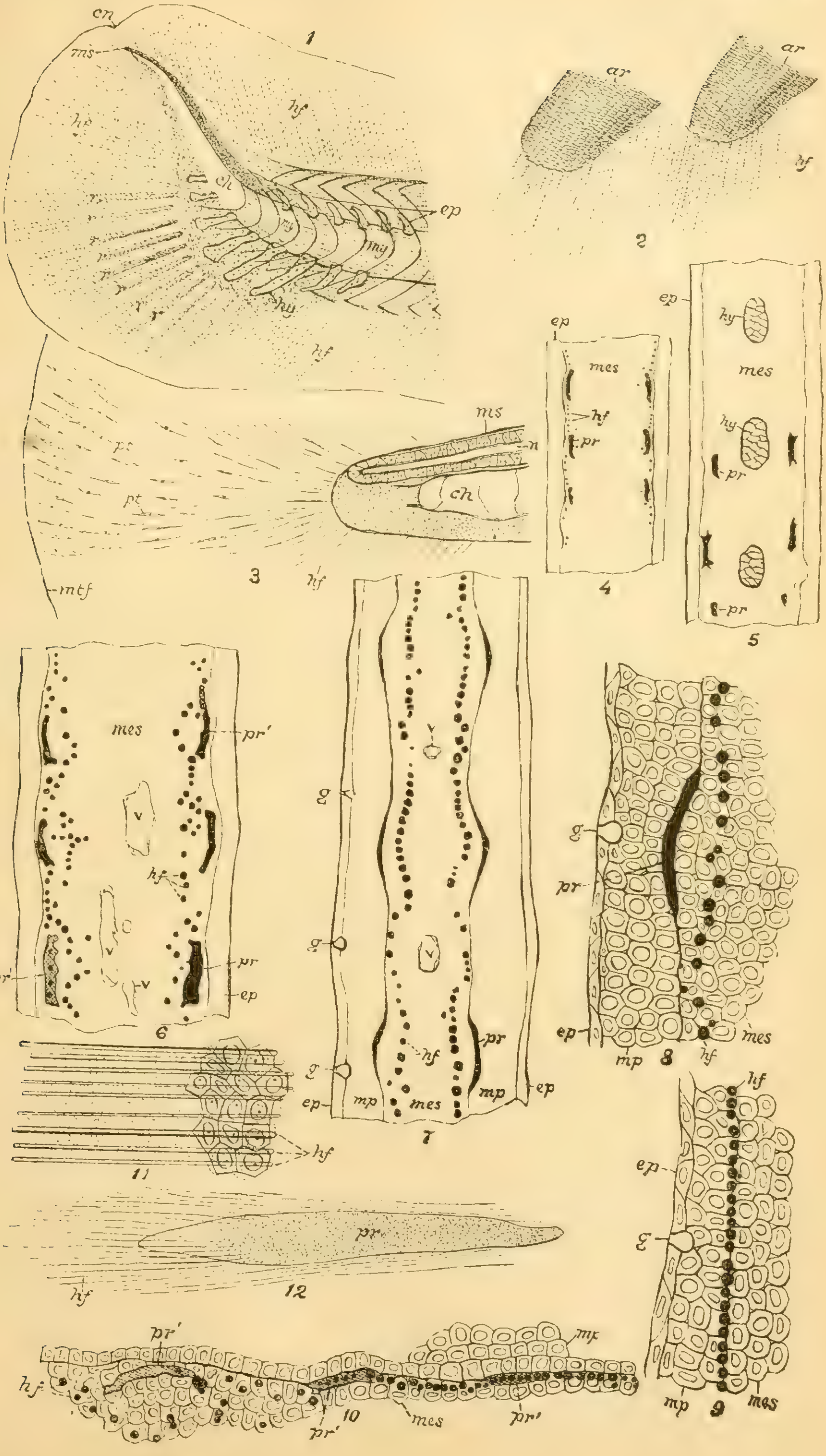
FIG. 8. More enlarged view of a section through the left half of the rudiment of a permanent ray of a young salmon, taken from the same plane as the preceding. Letters the same as in the preceding figure. x 365.

FIG. 9. A similar section from near the edge of the caudal fold of the salmon, to show the cylindrical horny fibers *hf* separate and lodged between the skin *ep* and *mp* and the mesoblast *mes*. x 365.

FIG. 10. A similar section through the layer of horny fibers between the lower layer of the epiblast *mp* and mesoblast *mes*, to show the mode in which the fibres are fused together and enveloped by the matrix of the future permanent rays. x 365.

FIG. 11. A small fragment of the epiblast of the fin-fold of a recently-hatched salmon, viewed from the surface, to show the perfectly straight horny fin-fibers *hf*, partially covered by mesoblastic cells. x 365.

FIG. 12. Diagram to illustrate the mode in which the matrix of the permanent fin-ray *pr* envelopes the horny fibers *hf*, which remain more or less divergent and free at their distal extremities.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EXPLANATION OF PLATE X.

FIG. 1. Section cutting longitudinally and vertically through the basal part of the Wolffian ridge of the chick, six days old; *n*, medulla spinalis; *shl*, hinder somites, which are drawn together more or less at their ventral end, where they are destined to furnish the muscular and nervous supply of the hind limb; *st*, thoracic somites; *hl*, hind limb; *fl*, fore limb. x 16.

FIG. 2. Longitudinal nearly vertical section through the base of the dorsal fin of an embryo of *Squalus* a little off of the median line, to show the muscular buds *mb mb*, which are thrust upward into the dorsal fin-fold, and from which the muscular apparatus of the fin is derived; *ep*, epiblast; *c*, connective tissue. x 35.

FIG. 3. Transverse section through the pectoral fin of a young embryo of *Scyllium stellare*, from Balfour; *v v*, vessels; *mpt*, basipterygial bar (metapterygium); *m*, muscles; *cr*, cartilaginous rays; *mes*, mesoblast; *hf*, horny fibers between mesoblast and epiblast.

FIG. 4. Pelvic fin of a very young female embryo of *Scyllium stellare; bb*, basipterygium; *pu*, pubic process of pelvic girdle; *il*, iliac process of pelvic girdle; *f*, foramen through pelvic plate; *hf*, horny fibers. From Balfour.

FIG. 5. Transverse section through the pectoral fin of a recently hatched salmon; *v v*, vessels; *bc*, pericardiac cavity; *ao*, aorta; *dc*, ductus Cuvieri; *cl cl*, membranous matrix of clavicle; *bp*, basipterygial or cartilaginous pectoral plate; *mes* and *c*, mesoblast or connective tissue; *my*, myotomes; *hf*, horny fibers; *m*, muscles of pectoral inserted into the edge of the pectoral plate; *ep*, epiblast.

FIG. 6. A nearly median section through the dorsal of *Amiurus*, fifteen days old; *is′ is′*, basilar interneural or median actinophoral cartilages; *i i*, interneurals; *r r*, membranous matrix of permanent rays, the last one, *r′*, showing the effects of concresence at its lower end; *c*, connective tissue; *es′*, supracarinal muscle; *es*, erectores, and *ds*, depressores spinæ muscles; *my*, myotomes. x 35.

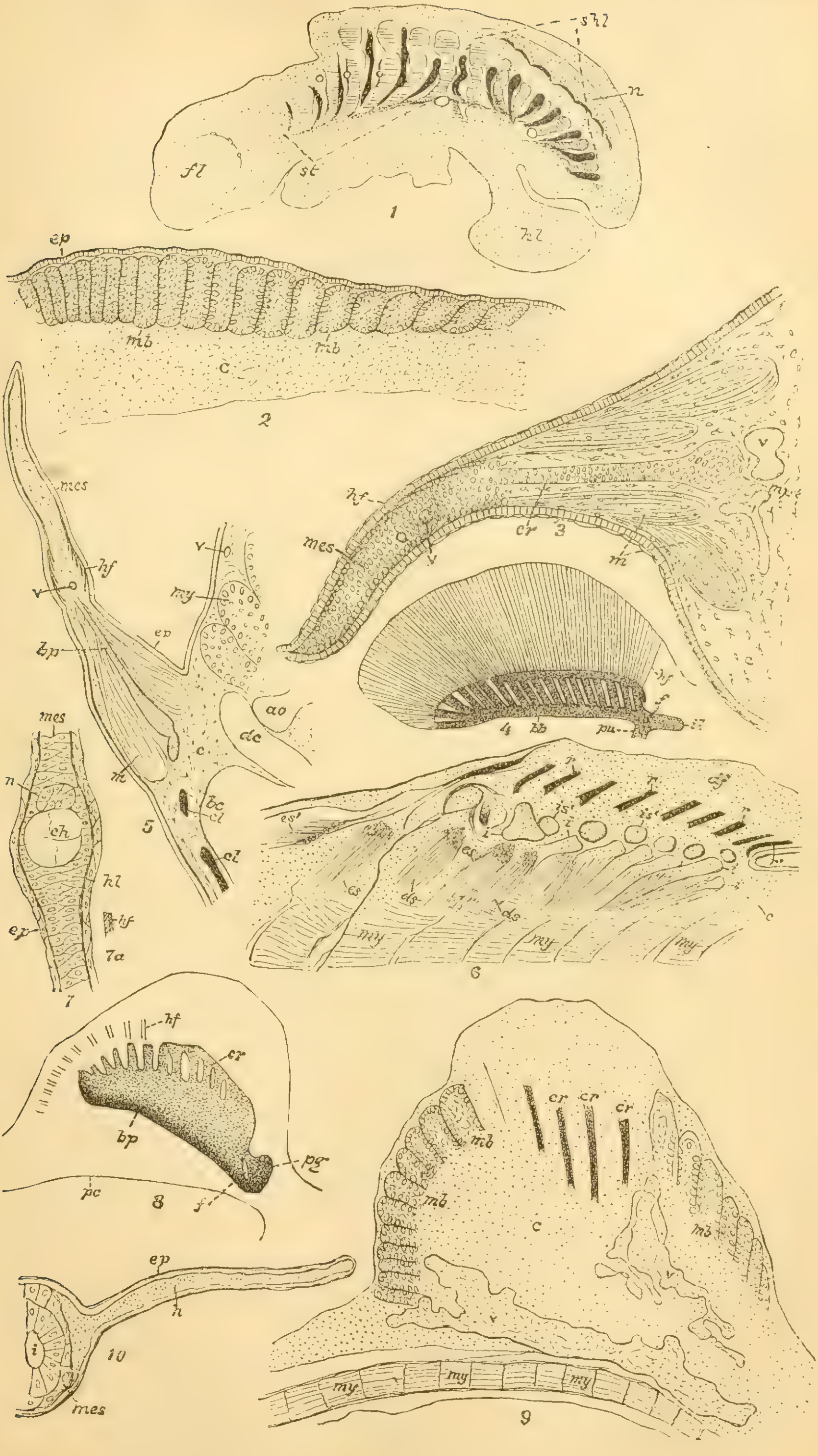
FIG. 7. Transverse section through the central part of the tail of the shad (*Alosa*), cutting the chorda, *ch*, and medulla spinalis, *n*; *ep*, epiblast; *mes*, mesoblast, with the horny layer *hl* between them. x 96.

FIG. 7*a*. A portion of the horny layer *hl* of the preceding nearly opposite the chorda, which shows itself differentiated into embryonic rays or fibers *hf*. x 600.

FIG. 8. Pectoral fin of a young embryo of *Scyllium* in longitudinal and horizontal section; *pc*, wall of peritoneal cavity; *f*, foramen in the pectoral girdle; *pg*, pectoral girdle in transverse section; *cr*, cartilaginous rays; *hf*, horny fibers or rays.

FIG. 9. Horizontal longitudinal section through the pectoral of an embryo of *Squalus* to show some of the muscular buds, *mb*, which have been thrust out by the post-branchial somites into the pectoral fold; *cr cr*, rudiments of cartilaginous rays; *v v*, vessels; *my*, *my* myotomes. x 35.

FIG. 10. Transverse section through the ventral fin-fold of a recently-hatched shad embryo in front of the anus; *i*, intestinal lumen; *mes*, mesoblast; *ep*, epiblast or larval skin; *h*, homogeneous matter which fills the fin-fold before the embryonic rays are differentiated. x 96.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EXPLANATION OF PLATE XI.

d, dorsal; *p*, pectoral; *p'*, pelvic fin.

FIG. 1. Young *Lophius* taken out of the egg just previous to hatching, showing the pelvic fin-fold behind the pectoral.

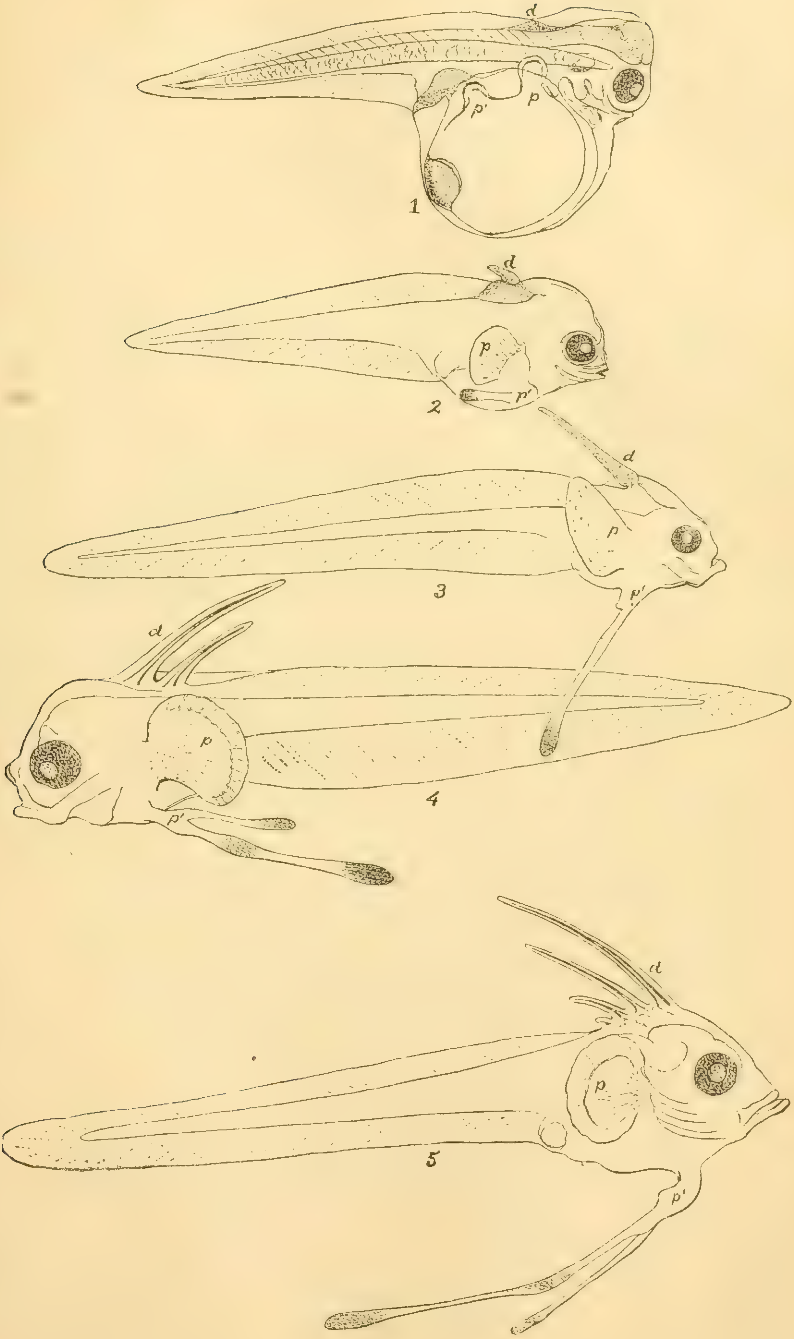
FIG. 2. *Lophius* just after hatching, showing the pelvic fin *p'* in a jugular position below the pectoral, with first dorsal spine appearing as a fleshy process.

FIG. 3. An older stage, with second ray of pelvic fin growing out from the base of the first.

FIG. 4. A still older stage, with two dorsal and two pelvic rays developed.

FIG. 5. A more advanced embryo, with four dorsal rays and the rudiment of a third pelvic fin-ray.

All the figures on this plate are taken from those published by A. Agassiz, but are considerably reduced and rendered diagrammatic.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p'
5

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XXXVIII.—ON THE RELATIVE DIGESTIBILITY OF FISH FLESH IN GASTRIC JUICE.

By R. H. Chittenden and George W. Cummins.

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The value of food as nutriment depends primarily upon the presence in suitable quantity of elements, or combinations of elements, capable of supplying the needs of the body; coupled with this, however, is the ease with which the food stuff in question can be rendered available by the system for its wants. This, or in other words its digestibility, constitutes a very important item in determining the true nutritive value of any food. If, of two foods possessing a like chemical composition, one is more easily digestible, that one, though containing no more available nutriment than the other, is in virtue of its easier digestibility more valuable as a food stuff, and in one sense more nutritious as well as more economical for the system.

Both chemists and physiologists have appreciated the importance of all data relative to the nutritive value of foods. But hitherto nearly all work in this direction has been confined to a study of chemical composition, and only occasionally to digestibility. The mere fact, however, that a substance contains a certain percentage of nitrogen is not alone sufficient. We need to know in addition, not only how much of the nitrogen passes through the body unabsorbed, thus indicating how much is ordinarily available for nutriment, but we need to know likewise how long the food stuff remains in the stomach, how quickly it is acted upon by the digestive juices, and, finally, how much passes out undigested—points of great importance to the healthy system, but still more so to the system weakened by disease.

There are two ways of determining the digestibility of a food stuff in gastric juice. One consists in the introduction of a weighed amount of the subtance into the stomach of a man or animal through a fistulous opening, and noting the length of time required for its solution; the other, in the use of an artificial gastric juice by which the amount of substance capable of being dissolved and digested in a given time can be quantitatively ascertained. The first of these methods was made use of by Dr. Beaumont in his celebrated experiments on the Canadian, Alexis St. Martin, about 1830, and has been employed many times

since with animals by other workers. While it would appear in some respects to be the better method, there are reasons why it is not so advantageous as the other, mainly because it is not capable of showing such small differences, it is not free from nervous influences and personal idiosyncrasies, and, lastly, it is less convenient. The method with artificial gastric juice, on the other hand, admits of the conditions being the same in each case; and, since the digestion of a food is by itself simply a chemical process, it would seem better in a determination of digestibility that the process be shorn of all those conditions, natural or otherwise, which tend to interfere with the purely chemical action of the digestive juice.

Few experiments appear to have been made on the digestibility of fish; this is the more strange when we consider what an important item of food fish constitutes, particularly along our seaboard. Yet the idea is prevalent, based apparently on general grounds, that fish flesh is not easily digestible. Thus Maly[1] mentions that "fish flesh is difficult of digestion, although the reason is not known." Still, as Voit[2] remarks, "nothing certain is known regarding the digestibility of different kinds of flesh, although much is said concerning it. Probably digestibility is in part dependent upon the nature of the fat present and the manner of its distribution; thus the presence of a difficultly fusible fat with considerable stearin would tend to hinder digestibility (as in mutton); the same thing probably occurs when the contents of the sarcolemma are permeated with much fat (as in the lobster and eel)." This statement at once suggests the probability of great variation in the digestibility of the flesh of any one species, dependent on a large number of conditions, which, in the case of fish particularly, are somewhat difficult of control; thus age, sex, food, period of spawning, length of time they have been preserved, are a few of the many natural conditions which would tend to modify the digestibility of the flesh and render generalizations from even a large number of results somewhat uncertain.

Still, as no systematic experiments appear ever to have been tried with fish flesh, we have attempted to obtain some positive results concerning the relative digestibility of the more common edible species, as well as the general digestibility of fish as compared with beef, veal, lamb, &c.

THE METHODS EMPLOYED.

The gastric juice.—For reasons already given, artificial digestion was chosen as the best adapted for the purpose, and with this end in view a gastric juice was needed which should be both constant in composition and activity during the length of time required for trying the experiments. A large quantity of so-called "pure pepsin"[3] was

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[1] Hermann's *Handbuch der Physiologie*, 5, 112.

[2] *Ibid.*, 6, 447.

[3] Manufactured by Henry Thayer & Co.

obtained, thoroughly sampled, and then placed in a tightly stoppered bottle and kept in a cool, dry place to prevent change. The acid used was pure hydrochloric of exactly 0.2 per cent strength. From this material fresh gastric juice was made for each series of experiments, 5 grams of the pepsin being dissolved in 1 liter of the dilute acid. This furnished a digestive mixture of suitable strength, and, as subsequent experiments showed, well adapted to the purpose.

Preparation of the flesh.—In order that a fair sample of the flesh might be obtained in each case, 100 grams, freed from tendons, fat, skin, and bones, were weighed off and finely divided by chopping. Small portions of the sample tissue were then taken for a determination of the amount of solid matter,[1] and then two portions of 20 grams each were weighed out to determine the digestibility. These two latter portions were placed in small porcelain mortars covered with watch glasses, and then set into a steam-bath heated by a large gas flame for 30 minutes. This bath was a small copper oven, on the bottom of which was a layer of water 1 or 2 inches in depth, while some distance above this was placed a perforated plate upon which the dishes were set, the whole provided with a tightly fitting cover, with a small outlet for the escaping steam. Heated in this for half an hour the fish or meat was thoroughly and evenly cooked without loss of any extractives, and being in mortars, the tissue after steaming could be ground up fine without loss. The flesh was then ready for digestion.

The digestion.—As already stated, two separate or duplicate determinations were made of each sample. Each portion of 20 grams was placed in a beaker with 200 cubic centimeters of the standard gastric juice, covered with a watch glass and set into a bath heated at 38° to 40° C. for 22 hours with occasional stirring. This bath consisted of a metal box with a movable cover, and having about midway of its height a perforated plate upon which the beakers were placed. The bath was filled with water to such an extent that the beakers were immersed about half an inch. The space above, when the bath was closed, was of course saturated with aqueous vapor, and thus any evaporation of the contents of the beakers was prevented. The temperature was kept quite constant by a small gas flame, and the extreme variations were not more than 35° to 42° C., these occurring only during the night and early morning. The length of time the mixtures were heated, namely, 22 hours, was no longer than was necessary to insure accurate and concordant results. In an artificial digestion the accumulation of the products formed tends to retard the action of the fluid, but in no case were our results impaired by saturation of the digestive mixture, for that this could never have occurred ordinarily is plainly shown by the large amount of *blood fibrin* dissolved by the gastric juice in a trial experiment. The addition of larger amounts of flesh, moreover, in the case of fish, 30 to 40 grams, simply diminished the digestive action.

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[1] Determined by simply drying at 100° C. until of constant weight.

Determination of the amount digested.—This can be accomplished by either weighing the undigested residue, or by determining directly the amount dissolved. In a recent work by Jessen[1] on the influence of different modes of preparation on the digestibility of meat, the former method was used. Unless the amount of water contained in the meat experimented with, however, is determined, a very decided error may be introduced. Thus Jessen found by experiment with frogs' legs[2] that 2 grams of the raw flesh, introduced into the stomach of a dog, required on an average 4.46 hours for digestion, while the same amount of beef, similarly prepared, required on an average 5.58 hours, and thus from this experiment the relative digestibility of the two would be as 84:100. Our experiments, however, show quite a different result, easily explained by a determination of the percentage amount of solid matter in the two kinds of flesh. Thus, while 20 grams of beef contain on an average 5.1 grams of solid matter, the flesh of frogs' legs contains but 3.5 grams. It is evident from this example, then, that a determination of the total solid matter is necessary in each species of flesh; but even when that is done, and corrections made accordingly we have found a decided difficulty in filtering the digestive mixtures. The undissolved residue of the fish is so gelatinous that it is next to an impossibility to wash it entirely free from peptones. We therefore decided to work with the filtrate, and after several trials by precipitating the dissolved albumen with tannic acid, according to the method of Johnson,[3] and also by determining the specific gravity of the fluid after filtration, we finally adopted the following method, which has proved quite satisfactory. After the gastric juice has been allowed to act for the requisite length of time on the 20 grams of flesh the mixture is cooled to 20° C., and then diluted to 250 cubic centimeters, in a graduated flask, with distilled water. After being thoroughly mixed it is filtered on a dry filter, and then 50 cubic centimeters, or one-fifth of the entire mixture, is transferred by a pipette to a small weighed dish, and to it are added 5 cubic centimeters of a standard solution of sodium carbonate of such strength as exactly to neutralize the acid present. The fluid is then evaporated to dryness on the water-bath, and finally dried at 110° C. until of constant weight. In order that the results obtained may express the absolute amounts of matter dissolved by the gastric juice, it is necessary to carry on control experiments with the gastric juice itself. This is also desirable as a proof of the uniform strength of the gastric juice. Thus in each series of experiments 200 cubic centimeters of the standard juice were warmed at 38° to 40° C. for 22 hours, so that all albumen contained in the pepsin could be converted into peptone, then diluted to 250 cubic centimeters and 50 cubic centimeters, neutralized, evaporated, and dried as already described. This residue, subtracted from the

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[1] *Zeitschrift für Biologie*, 19, 130.

[2] *Ibid.*, p. 140.

[3] *Bulletin de la Société chimique de Paris*, 23, 40.

weight of the residue left by the evaporation of the 50 cubic centimeters of the digestive mixtures, multiplied by 5, gives quite accurately the amount of matter (peptones and intermediate products together with some salts) dissolved from the 20 grams of flesh. Theoretically there are one or two minor objections to this method, the most noticeable, perhaps, being the variable amount of undigested residue suspended in the fluid diluted to 250 cubic centimeters. The amount of space, however, occupied by this matter is not large, and its influence on the accuracy of the method not great. Again, by the evaporation of the peptones, and drying at 110° C., there is doubtless some slight oxidation, but still it cannot be great, as the dried residue is soon brought to a constant weight. While the method seems longer than to weigh the undissolved residue, it is by far more accurate, and in the end we believe shorter.

The fish experimented[1] with were obtained at a local market, and, while always quite fresh and in good condition, we had no means of knowing how long they had been out of water.

In all of the experiments the flesh was cooked by steaming, unless otherwise expressed.

Tables I to V give all the data of the experiments, while Table VI contains the average amounts digested of each sample of cooked flesh, together with the relative digestibility as compared with cooked (steamed) beef, taken as 100.

A glance at the results of the control analyses of the gastric juice alone plainly shows the constancy of its composition. The strength and activity of the digestive mixture, moreover, is easily seen from the amount of blood fibrin (Table IV) dissolved by 200 cubic centimeters of the fluid; an amount far in excess of the fish or beef dissolved by the same quantity of fluid.

The results of the analyses show plainly that the method adopted is as good as could be expected, for it must be remembered that the two results obtained from each sample of flesh are not merely from duplicated analyses, but from duplicated digestions as well, and in these, extending as they do over 22 hours, with slight variations in temperature and agitation, small differences are to be expected. The very great divergence noticed, however, in the results obtained from different samples of the same species of flesh show at once that there are other conditions, such as age, &c., which affect the digestibility of the flesh more or less, so that, in order to obtain results from which to draw strict generalizations, it would be necessary to experiment with fish of different species, of like age, sex, and reared under like conditions. As examples of this we have the very divergent results from two samples of veal, and also of two bluefish (88.69 and 73.44). As direct evidence that age, sex, &c., do exert a modifying influence on the digesti-

[1] For composition of the fish experimented with, see "*Zur Chemie der Fische,*" *Berichte der deutsch. chem. Gesell.*, 16, 1839, by Prof. W. O. Atwater.

bility of flesh, we have three experiments on the flesh of the lobster: one with a small young lobster, a second with a large female, and a third with a large male of the same species. The duplicate digestions gave fairly concordant results; the average relative digestibility being for the young specimen 87.81, for the large female 79.06, and for the male 69.13. This shows plainly some modifying influence in the flesh itself. In composition, so far as the solid matter is concerned, there was no appreciable difference in the three samples. Bearing in mind, however, these possible variations, it is very evident from our results that the average digestibility of fish flesh is far below that of beef similarly cooked. In but two instances, in the case of shad and white fish, does the digestibility of fish flesh approach that of beef, although, from the average of our experiments, several are as easily digestible as mutton, lamb, and chicken.

Pavy[1] states that fish with white flesh, such as the whiting, &c., are less stimulating and lighter to the stomach, or more easy of digestion, than fish with more or less red flesh, as the salmon. Our experiments confirm this statement so far as digestibility is concerned. Thus the average digestibility of the salmon and trout is considerably below the average of the more digestible white fish. The difference between the digestibility of the light and the dark meat of the same fish is somewhat striking, as in the case of the shad, where the digestibility of the former was found to be 97.25, as compared with beef, while the dark flesh was 87.32. A similar difference, though very much smaller, is to be noticed between the light and dark meat of the chicken.

This difference in digestibility is in part due, without doubt, to the amount of fat present, for, as Pavy states, in the flesh of white fish there is but little fat, it being accumulated mainly in the liver of the animal, while in red fish there is more or less fatty matter incorporated with the muscular fibers. For a similar reason, eels, mackerel, and herring are, according to Pavy, less suited to a delicate stomach than some of the white fish, and our experiments show that in digestibility two of them stand below the more digestible white fish; mackerel, however, from our single experiment with the white portion of the flesh, showed a comparatively high digestibility. In all of our experiments, however, with white fish, we rejected the outer layer of dark flesh, except in the case of the shad. The varying differences in digestibility are not to be considered as due wholly to differences in the amount of fat in the flesh; thus the flesh of fresh cod contains but little fat, and yet it is one of the most indigestible of the white fish experimented with. This agrees with Pavy's[2] experience "that it is a more trying article of food to the stomach than is generally credited." Again, Pavy[3] makes the following statement, based on his experience in fish dietetics, "of all fish, the whiting may be regarded as the most delicate, tender, and easy of digestion."

[1] On food and dietetics, Amer. ed., 1874, p. 171.

[2] *Ibid.*, p. 173.

[3] *Ibid.*, p. 172.

"The haddock is somewhat closely allied, but is inferior in digestibility," while "the flounder is light and easy of digestion, but insipid." With all these statements our results agree perfectly, assuming the white-fish of our experiments to be analogous to the English whiting.

Maly,[1] in speaking of the digestive processes in the living stomach, says that raw flesh is more slowly digested than cooked, probably for the reason that with dilute acids the coagulated albumen of cooked flesh is more easily converted into acid albumen. Likewise, that the flesh of young animals is more rapidly digested than that of older ones, while fat flesh is but slowly attacked, as the melted fat surrounds the muscle fibers. With reference to the first of these statements, Jessen[2] found, by experimenting with perfectly lean beef of known age, that he had only a small indigested residue in an artificial digestion of the raw beef, but with the same amount of partially boiled beef a much larger amount remained indigested, and when thoroughly boiled a still larger residue was found. Taking the amount of indigested residue as a measure of the digestibility, the proportion with the same sample of beef was as follows: Raw beef, 100; partially boiled, 167; thoroughly boiled, 317. The gastric juice employed by Jessen, however, could hardly be considered as made up of a dilute acid, containing, as it did, 2.5 and 5 per cent of concentrated hydrochloric acid.

In our own experiments, with a gastric juice containing but 0.2 per cent of pure hydrochloric acid, positive results were obtained as follows:

	First sample of beef.		Second sample of beef.	
	Raw.	Cooked (steamed).	Raw.	Cooked (steamed).
Amount digested from 20 grams	4.0792	3.8610	4.3785	4.1607
Relative proportion	100.0	94.65	100.0	95.04

The difference here, then, is not so great, though sufficiently pronounced to indicate plainly the influence of cooking.

A similar experiment with a sample of bluefish gave a like result:

	Raw.	Cooked (steamed).
Amount digested from 20 grams	3.7617	3.5885
Relative proportion	100.0	95.39

With the raw beef, however, digestion was so near complete that a second experiment was tried with a larger quantity, as follows:

	From 20 grams.	From 30 grams.
Amount digested (raw beef)	4.3785	5.7610
Relative proportion	100.0	131.57

[1] Hermann's *Handbuch der Physiologie*, 5, 111.

[2] *Zeitschrift für Biologie*, 19, 128.

This would make the relative digestibility of cooked (steamed) and raw beef as 100 : 142.38, a difference nearly as great as that found by Jessen between raw and partially boiled beef. It is plain, then, that the digestibility of raw beef is considerably greater than cooked.

Whether the relative digestibility of raw and cooked fish, given above, would be changed by increasing the amount of flesh added, we cannot say. It is a point of little importance, but from the following experiment with cooked fish it probably would make but little difference. This experiment with cooked sea-bass was tried mainly to ascertain the quantity of flesh best adapted to 200 cubic centimeters of our standard gastric juice:

	From 20 grams.	From 30 grams.	From 40 grams.
Amount digested	3.3995	3.2325	2.52
Relative proportion	100.0	95.08	74.12

In this case, increasing the amount of material plainly diminishes the digestive action.

With regard to the second statement of Maly, above quoted, our experiments tend to show that, in some instances at least, the flesh of younger animals is less easily digestible than that of older animals of the same species. This is well illustrated in the greater digestibility of mutton as compared with lamb.

TABLE I.

	First series. April 18.				*Second series.* April 21.				*Third series.* April 23.				*Fourth series.* April 25.				*Fifth series.* April 28.			
	Hippoglossus vulgaris. Halibut.		Hiatula onitis. Tautog.		Salvelinus fontinalis. Brook-trout.		Scomber scombrus. Mackerel.		Esox lucius. Pike.		Roccus americanus. White Perch.		Pleuronectes americanus. Flat fish.		Perca americana. Yellow Perch.		Roccus lineatus. Striped Bass.		Salmo salar. Salmon.	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
Grams taken	5.8010	5.1408	6.6509	6.4162	4.9927	5.4913	4.6668	5.9266	7.3142	4.8280	6.9013	6.1971	6.4699	7.2258	7.7499	8.3051	7.4441	7.2179	8.9633	9.5412
Gave dried residue	1.1857	1.0350	1.3703	1.3102	.9634	1.0703	1.1755	1.5316	1.4384	.9467	1.3497	1.2236	1.1081	1.2445	1.4029	1.5069	1.5497	1.4924	2.8687	2.9580
Per cent solid matter	20.43	20.13	20.60	20.60	19.49	19.67	25.18	25.84	19.66	19.61	19.55	19.74	17.09	17.22	18.10	18.14	20.81	20.66	32.00	31.00
Average per cent solid matter	20.28		20.60		19.58		25.51		19.635		19.695		17.155		18.12		20.735		31.50	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
20 gr. sampled flesh and 200 cc. S. G. J. 22 hrs. at 40°—diluted to 250 cc. 50 cc. of this+5 cc. Na_2CO_3 gave dried residue	1.0070	1.0134	1.0223	1.0401	lost.	.9527	1.0201	1.0113	.9139	1.0540	.9102	.8950	.8437	.8641	.8962	.8905	.9612	.9764	1.0596	1.0206
200 cc. S. G. juice diluted to 250 cc. 50 cc. of this+5 cc. Na_2CO_3 gave dried residue	0.3180				0.3178				0.3123				0.3126				0.3134			
Residue from digestion less the gastric juice residue	.6890	.6954	.7043	.7221	....	.6349	.7023	.6935	.6016	.7117	.5979	.5827	.5311	.5515	.5836	.5779	.6478	.6630	.7462	.7072
The above × 5 or the entire products of digestion from 20 gr	3.4450	3.4750	3.5215	3.6105	....	3.1745	3.5115	3.4675	3.0080	3.7085	2.9895	2.9135	2.6555	2.7575	2.9180	2.8895	3.2390	3.3150	3.7310	3.5360
Average of the above	3.4600		3.5660		3.1745		3.4895		3.35825		2.9515		2.7065		2.9037		3.2770		3.6335	

TABLE II.

	Sixth series. April 30.				*Seventh series.* May 2.				*Eighth series.* May 5.				*Ninth series.* May 5.				*Tenth series.* May 12.			
	Sparus chrysops. Porgee.		Clupea sapidissima. Shad.		Lutjanus blackfordi. Red Snapper.		Anguilla rostrata. Eel.		Beef.		Veal.		Gadus æglifinus. Haddock.		Paralichthys dentatus. Flounder.		Bothus maculatus. Window-pane.		Prionotus palmipes. Sea-robin.	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
Grams taken	7.6491	6.9193	8.2493	7.9472	6.8025	6.9713	6.5942	6.6020	5.4199	6.7188	6.2437	5.7730	6.9118	5.9901	6.9864	7.0080	6.6987	4.7163	6.3035	7.1382
Gave dried residue	1.7221	1.5647	2.6035	2.4791	1.5038	1.5406	1.4380	1.4375	1.3963	1.7681	1.5607	1.4395	1.2601	1.0941	1.6188	1.6065	1.2301	.8670	1.3676	1.5745
Per cent solid matter	22.51	22.61	31.57	31.11	22.10	22.09	21.80	21.77	25.76	26.31	24.99	24.93	18.23	18.26	23.17	22.92	18.37	18.38	21.69	22.05
Average per cent solid matter	22.56		31.335		22.095		21.785		26.035		24.96		18.245		23.045		18.375		21.87	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
20 gr. sampled flesh and 200 cc. S. G. J. 22 hrs. at 40°—diluted to 250 cc. 50 cc. of this + 5 cc. Na_2CO_3 gave dried residue	1.0081	1.0215	1.0538	1.0254	.9707	.9837	.9004	.8959	1.1404	1.1355	1.1553	1.1436	.9841	.9850	1.0090	1.0058	.8949	.8904	.9293	.9571
200 cc. standard gastric juice diluted to 250 cc. 50 cc. of this + 5 cc. Na_2CO_3 gave dried residue	0.3105				0.3164				0.3146				0.3169				0.3141			
Residue from digestion less the gastric juice residue	.6976	.7110	.7433	.7149	.6543	.6673	.5840	.5785	.8258	.8209	.8407	.8290	.6672	.6681	.6921	.6889	.5808	.5763	.6152	.6477
The above × 5 or the entire products of digestion from 20 gr	3.4880	3.5550	3.7165	3.5745	3.2715	3.3365	2.9200	2.8925	4.1290	4.1045	4.2035	4.1450	3.3360	3.3405	3.4605	3.4445	2.9040	2.8815	3.0760	3.2385
Average of the above	3.5215		3.6455		3.3040		2.9062		4.1167		4.1742		3.3382		3.4525		2.8927		3.1572	

TABLE III.

	Eleventh series. May 14.				Twelfth series. May 19.				Thirteenth series. May 19.			
	Salmo salar. Salmon.		Gadus callarias. Cod.		Coregonus clupeiformis. Whitefish.		Homarus americanus. Lobster. Young.		Crab.		Pomatomus saltator. Bluefish.	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
Grams taken	4.3430	4.8259	5.5381	5.8758	6.3449	4.9515	3.3703	2.8816	5.1634	5.0654	6.6347	5.6929
Gave dried residue	1.3383	1.5110	1.0194	1.0684	1.6253	1.2639	.7300	.6297	1.2195	1.1922	1.2901	1.1109
Per cent solid matter	30.81	31.31	18.40	18.18	25.61	25.52	21.66	21.85	23.61	23.53	19.42	19.51
Average per cent solid matter	31.06		18.29		25.565		21.755		23.57		19.465	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
20 gr. sampled flesh and 200 cc. S. G. J. 22 hrs. at 40°—diluted to 250 cc. 50 cc. of this + 5cc. Na_2CO_3 gave dried residue	1.0663	1.0495	.8922	.9015	1.0826	1.0842	1.0153	1.0388	.8621	.8591	.8712	.9121
200 cc. standard gastric juice 22 hrs. at 40°—diluted to 250 cc. 50 cc. of this + 5 cc. Na_2CO_3 gave dried residue	0.3110				0.3164				0.3123			
Residue from digestion less the gastric juice residue	.7553	.7385	.5812	.5905	.7662	.7678	.6989	.7221	.5498	.5368	.5589	.6298
The above × 5 or the entire products of digestion from 20 gr.	3.7765	3.6925	2.9060	2.9525	3.8310	3.8390	3.4945	3.6120	2.7490	2.6840	2.7945	3.1490
Average of the above	3.7345		2.9292		3.8350		3.5532		2.7165		2.9717	

	Fourteenth series. May 22.				Fifteenth series. June 2.			
	Cynoscion regale. Weakfish.		Veal.		Clupea harengus. Herring.		Stromateus triacanthus. Butter-fish.	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
Grams taken	5.6586	5.6039	5.4457	4.4465	5.5057	4.7300	4.8831	3.7325
Gave dried residue	1.1279	1.1006	1.3332	1.0719	1.3483	1.1500	1.1186	.8513
Per cent solid matter	19.93	19.64	24.48	24.10	24.47	24.52	22.97	22.81
Average per cent solid matter	19.785		24.29		24.495		22.89	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
20 gr. sampled flesh and 200 cc. S. G. J. 22 hrs. at 40°—diluted to 250 cc. 50 cc. of this + 5cc. Na_2CO_3 gave dried residue	.9090	lost.	1.0132	1.0397	.9780	.9811	.9570	.9644
200 cc. standard gastric juice 22 hrs. at 40°—diluted to 250 cc. 50 cc. of this + 5 cc. Na_2CO_3 gave dried residue	0.3154				0.3137			
Residue from digestion less the gastric juice residue	.5836	......	.6978	.7143	.6643	.6674	.6343	.6507
The above × 5 or the entire products of digestion from 20 gr.	2.9180	......	3.4890	3.5215	3.3265	3.3370	3.1715	3.2535
Average of the above	2.9180		3.5052		3.3317		3.2125	

TABLE IV.

	Sixteenth series. May 7.				*Seventeenth series.* June 2.				*Eighteenth series.* June 2.				*Nineteenth series.* June 3.				*Twentieth series.* June 16.			
	Serranus atrarius. Sea-bass.		Serranus atrarius. Sea-bass.		Beef.		Beef.		Clupea sapidissima. Shad. Dark meat.		Clupea sapidissima. Shad. White meat.		Beef.		Beef.		Lobster. Large male.		Blood fibrin.	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*		
Grams taken	5.2485	6.0050	......	......	5.8633	5.7788	......	......	4.0414	4.4000	6.6883	5.1362	4.6522	5.0094	......	......	4.6161	5.1282	......	......
Gave dried residue	1.1153	1.2872	......	......	1.4781	1.4471	......	......	1.3118	1.4640	2.0627	1.5359	1.2089	1.2842	......	......	.9643	1.0610	......	......
Per cent solid matter	21.24	21.10	......	......	25.20	25.04	......	......	32.46	32.81	30.84	29.93	25.75	25.63	......	......	20.89	20.64	......	......
Average per cent solid matter	21.17		21.17		25.12		25.12		32.63		30.38		25.69		25.69		20.76			
	20 gr.	20 gr.	30 gr.	40 gr.	20 gr.	20 gr.	20 gr. raw.	30 gr. raw.	20 gr.	20 gr.	20 gr.	20 gr.	20 gr. raw.	20 gr. raw.	20 gr.	20 gr.	20 gr.	20 gr.	Added indef. quant.	
Sample flesh and 200 cc. S. G. J. 22 hrs. at 40°—diluted to 250 cc. 50 cc. of this + 5 cc. Na_2CO_3 gave dried residue	.9919	.9999	.9625	.8200	1.1476	1.1493	1.1920	1.4685	1.0290	1.0225	1.1156	1.0867	1.1329	1.1244	1.0668	1.1032	.8325	.9141	1.9238	......
200 cc. standard gastric juice diluted to 250 cc. 50 cc. of this + 5 cc. Na_2CO_3 gave dried residue	0.3160				0.3163				0.3141				0.3128				0.3141			
Residue from digestion less the gastric juice residue	.6759	.6839	.6465	.5040	.8313	.8330	.8757	1.1522	.7049	.7084	.8015	.7726	.8201	.8116	.7540	.7904	.5184	.6000	1.6097	......
The above × 5 or the entire products of digestion from 20 gr.	3.3795	3.4195	3.2325	2.5200	4.1565	4.1650	4.3785	5.7610	3.5245	3.5420	4.0075	3.8630	4.1005	4.0580	3.7700	3.9520	2.5920	3.0000	8.0485	......
Average of the above.	3.3995		3.2325	2.5200	4.1607		4.3785	5.7610	3.5332		3.9352		4.0792		3.8610		2.7960		8.0485	

TABLE V.

	Twenty-first series. June 4.				Twenty-second series. June 9.				Twenty-third series. June 16.				Twenty-fourth series. June 18.			
	Lamb.		Mutton.		Pomatomus saltator. Bluefish.		Pomatomus saltator. Bluefish.		Light meat of spring chicken.		Dark meat of spring chicken.		Frogs' legs.		Lobster. Large female.	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
Grams taken	4.4828	5.1652	5.2508	4.7776	5.1936	5.8776	......	......	4.7043	4.6394	4.3887	4.6880	5.1115	3.6942	4.3595	4.7139
Gave dried residue	1.3533	1.5272	1.6352	1.4594	1.0328	1.1639	......	......	1.2518	1.2384	1.1585	1.2742	.9105	.6618	.9238	1.0080
Per cent solid matter	30.18	29.56	31.14	30.54	19.88	19.80	......	......	26.60	26.69	26.39	27.01	17.81	17.91	21.19	21.39
Average per cent solid matter	29.87		30.84		19.84		19.84		26.645		26.70		17.86		21.29	
	a	*b*	*a*	*b*	*a* raw.	*b* raw.	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*	*a*	*b*
20 gr. sampled flesh and 200 cc. S. G. J. 22 hrs. at 40°—diluted to 250 cc. 50 cc. of this + 5 cc. Na_2CO_3 gave dried residue	1.0313	1.0201	1.0753	1.0444	1.0632	1.0713	1.0412	1.0239	1.0308	1.0010	.9991	.9955	.9724	.9611	.9575	.9541
200 cc. standard gastric juice diluted to 250 cc. 50 cc. of this + 5 cc. Na_2CO_3 gave dried residue	0.3141				0.3149				0.3141				0.3160			
Residue from digestion less the gastric juice residue	.7172	.7060	.7012	.7303	.7483	.7564	.7264	.7090	.7167	.6869	.6850	.6814	.6564	.6451	.6415	.6381
The above × 5 or the entire products of digestion from 20 gr	3.5860	3.5300	3.8060	3.6515	3.7415	3.7820	3.6320	3.5450	3.5835	3.4345	3.4250	3.4070	3.2820	3.2250	3.2075	3.1905
Average of the above	3.5580		3.7287		3.7617		3.5885		3.5090		3.4160		3.2535		3.1990	

TABLE VI.

Average results from each sample of cooked flesh.

	Percentage solid matter.	Solid matter in 20 grams.	Average amount digested from 20 grams.	Relation of the amounts digested to the amount digested from 20 grams cooked beef = 4.0461.
Beef	25. 12	5. 024	4. 1607	
Beef	26. 03	5. 206	4. 1167	= 100. 00
Beef	25. 69	5. 138	3. 8610	
Veal	24. 96	4. 992	4. 1742	= 94. 89
Veal	24. 29	4. 858	3. 5052	
Mutton	30. 84	6. 168	3. 7287	92. 15
Lamb	29. 87	5. 974	3. 5580	87. 93
Spring chicken (light meat)	26. 64	5. 328	3. 5090	86. 72
" (dark meat)	26. 70	5. 340	3. 4160	84. 42
Whitefish (Coregonus clupeiformis)	25. 56	5. 112	3. 8350	94. 78
Shad (Clupea sapidissima)	31. 33	6. 266	3. 6455	90. 09
" " (light meat)	30. 38	6. 076	3. 9352	97. 25
" " (dark meat)	32. 63	6. 526	3. 5332	87. 32
Salmon (Salmo salar)	31. 06	6. 212	3. 7345	92. 29
" "	31. 50	6. 300	3. 6335	89. 80
Tautog (Hiatula onitis)	20. 60	4. 120	3. 5660	88. 13
Porgee (Sparus chrysops)	22. 56	4. 512	3. 5215	87. 03
Bluefish (Pomatomus saltator)	19. 84	3. 968	3. 5885	88. 69
" "	19. 46	3. 892	2. 9717	73. 44
Mackerel (Scomber scombrus)	25. 51	5. 102	3. 4895	86. 24
Halibut (Hippoglossus vulgaris)	20. 28	4. 056	3. 4600	85. 51
Flounder (Paralichthys dentatus)	23. 04	4. 608	3. 4525	85. 32
Sea-bass (Serranus atrarius)	21. 17	4. 234	3. 3995	84. 01
Pike (Esox lucius)	19. 63	3. 926	3. 3582	82. 99
Haddock (Gadus æglifinus)	18. 24	3. 648	3. 3382	82. 50
Herring (Clupea harengus)	24. 49	4. 898	3. 3317	82. 34
Striped Bass (Roccus lineatus)	20. 73	4. 164	3. 2770	80. 99
Red Snapper (Lutjanus blackfordi)	22. 09	4. 418	3. 3040	81. 65
Brook-trout (Salvelinus fontinalis)	19. 58	3. 916	3. 1745	78. 45
Sea-robin (Prionotus palmipes)	21. 87	4. 374	3. 1572	78. 03
White Perch (Roccus americanus)	19. 69	3. 938	2. 9515	72. 94
Fresh Cod (Gadus callarias)	18. 29	3. 658	2. 9292	72. 39
Weakfish (Cynoscion regale)	19. 78	3. 956	2. 9180	72. 11
Yellow Perch (Perca americana)	18. 12	3. 624	2. 9037	71. 76
Eel (Anguilla rostrata)	21. 78	4. 356	2. 9062	71. 82
Window-pane (Bothus maculatus)	18. 37	3. 674	2. 8927	71. 49
Flat-fish (Pleuronectes americanus)	17. 15	3. 430	2. 7065	66. 89
Lobster (young)	21. 75	4. 350	3. 5532	87. 81
" (large female)	21. 29	4. 258	3. 1990	79. 06
" (large male)	20. 76	4. 152	2. 7960	69. 13
Crab	23. 57	4. 714	2. 7165	67. 13
Frogs' legs	17. 86	3. 572	3. 2535	80. 46

XXXIX.—THE MIGRATIONS OF EELS.*

By DR. OTTO HERMES.

The Swedish superintendent of fisheries, Dr. R. Lundberg, has published an interesting pamphlet on the eel-fisheries with so-called "hommor" on the Swedish coasts along the Baltic and the Sound, giving accurate observations on the migrations of eels on the coasts of Sweden, which, in the main points, strengthen the supposition that the mature eels seek the water of the Kattegat and the North Sea—which is salter than the Baltic—for the purpose of spawning. These observations agree with those of Mr. Dallmer, which have been reported in these circulars (1880, p. 200; 1881, p. 18), and of which Dr. Lundberg does not seem to have had any knowledge. It is nevertheless a fact of considerable interest that Dr. Lundberg, without knowing anything of Mr. Dallmer's observations, was, by his practical experiences, led to employ the same method for his own observations. For, as Mr. Dallmer states in a letter to the committee of the German Fishery Association, the "hommor" used in Sweden for catching the migrating eel, are, though somewhat different in form, still in principle, in construction, and in the manner in which they are used, the same as our eel-baskets. With due regard to the habit of the eel, to migrate along the coast, the "hommor" fisheries are only carried on during the latter part of summer and autumn.

After Dr. Lundberg has given a sketch of the extent of the "hommor" fisheries he arrives at the conclusion that from these fisheries the route taken by the eels during their migrations along the coast can easily be recognized. It appears that the eels, after having avoided certain portions of the Swedish coast, such as the coast of Sodermanland, &c., cross from the Cape of Falsterbo towards the Danish coast, and do not again approach the Swedish coast till they have reached the narrowest part of the sound near Helsingborg. The reason why the eels in their migrations do not follow the Swedish coast altogether is sought by Dr. Lundberg in the varying depth of water along the coast, in the currents, and other circumstances which still need investigation. Pos-

*"*Zur Wanderung der Aale.*"—From circular No. 2, 1884, of the German Fishery Association, Berlin, February 27, 1884. Translated from the German by HERMAN JACOBSON.

sibly the attempts to introduce the "hommor"-fisheries have not been made everywhere with the same degree of energy.

The migrations of the eels along the coast have not attracted the attention of naturalists as much as they deserve. It is true that men like Kröyer, Nilsson, and others have pointed out that this was a matter of great interest, but in works on the fauna it is mainly only the question as to the young fry of the eel ascending the rivers from the sea which is treated. That the fish migrate along the coast is proved by the position in which the fishing apparatus or the "hommor" has to be placed, if the fisheries are to be successful. On the east coast the "hommor" are placed in such a manner that the eels have to enter them from the north, while on the south coast the fish have to enter them from the east, and in the sound from the south. On the Danish coasts, in the Great and Little Belts, the eels coming from the east and south are likewise reported to wander in a northwestern direction towards the Kattegat. Everywhere the fishermen maintain that there is no use in placing the fishing apparatus in another position; they say that the eel approaches the land from deep waters, where it turns and is led into the "hommor" in the natural course of its migration. The idea suggested thereby, that the migration along the coast is nothing but describing a circle from the depths to the coast, and back, is thoroughly refuted by the method of placing the "hommor."

There is, therefore, no doubt that a migration of the eels takes place along the coasts of the Baltic towards the sound and the Kattegat, and there can be but little doubt as to the cause of it. It is most assuredly connected with the process of propagation. As the salmon ascends the rivers from the sea, and does not reach sexual maturity till that period, the eel, reversing this, seeks the salter water, which seems necessary for maturing its sexual organs. Where and at what time the eels spawn in the sea is still an open question, which can only be answered satisfactorily by continued observations and investigations.

The time when the eel-fisheries are carried on along the Swedish coast corroborates the supposition of the migration along the coast, referred to above. These fisheries commence at Grissleham and Landfort in July, in East Gothland and the Kalmar district towards the end of July and last till October, while in Schonen the fisheries commence in August, and do not yield many fish till September and October. In the sound the eel-fisheries do not commence before September. The first eels are here generally caught in October. At Humlebeck, on the Danish coast of the sound, about a mile from Elsinore, the eel-fisheries commence towards the end of October and do not come to a close till the 10th of November. This shows that the ideas relative to the migrations of the eel along the coast towards the Kattegat, expressed above, are very probably correct.

As in Komacchio, so also in Sweden, experience has taught that dark, stormy, and rainy nights are most favorable to the eel-fisheries. In

many places the fishermen will not set their fishing apparatus in moonlight nights. The eels seem principally to stir about during the night, for during the day they are but rarely caught. The moon and the currents also have considerable influence on the fisheries; but the imperfect data which we possess do not justify us in drawing any definite conclusions.

Although statistics on this subject were not collected till the year 1879, it appears from these incomplete data that the Swedish eel-fisheries are of great economical importance. In East Gothland there were in use in 1880, 312 "hommor," with which 24,097 kilograms (about 53,000 pounds) of eels were caught, representing a value of 17,010 crowns ($4,558.68). In the Kalmar district the number of "hommor" was 1,144, yielding 40,000 kilograms (about 88,000 pounds) of eels, valued at 27,900 crowns ($7,447.20).

In the district of Christianstadt the value of the eels caught in 1879 was 138,629 crowns ($37,152.57), and in Schonen 151,239 crowns ($40,532.05). Most of the eels caught in the northern districts of Sweden are sent to Stockholm and Norrköping, while those caught in the Blekinge and Ostschonen are bought by German dealers and are sent to Berlin via Stettin.

Mr. Dallmer, in his letter referred to above, calls attention to the fact that we lack data from the coasts of Mecklenburg and Pomerania, but that the observations made by Dr. Lundberg, Dr. Benecke, and by himself prove to a certainty that the Sound and the Belt—therefore salter waters than the Baltic—are the points towards which the eels direct their autumnal migration from the Baltic. He does not doubt, either, that this migration is in some way connected with the process of propagation, and points to the fact that Dr. Benecke (in his work, "*Fische, Fischerei, und Fischzucht in Ost- und Westpreussen*," p. 181) has determined the development of the eggs by measurements taken during the months of September, October, and November.

Dallmer concludes his remarks by pointing out the practical importance of the observations as far as they go. "The observations on this subject which have been made so far are in my opinion not only of scientific interest, but are probably of considerable importance to the fishing-industries, for I have no doubt that there are many and extensive portions of our German coast on the Baltic along which eels migrate without its being generally known, or without fisheries employing eel-baskets. It was at my suggestion that the minister of the interior granted a sum of money for obtaining eel-baskets for the purpose of making experiments with the same. These experiments unfortunately commenced a little too late last autumn, but it is expected that during the present year they will fully corroborate the facts given above relative to the migrations of the eels. Although we are not able to chronicle during the present autumn (1883) very large numbers of eels

caught in these eel-baskets, this does not signify anything, as during this autumn the eel-fisheries were very poor all along the east coast of Schleswig-Holstein. It seems that the eels kept nearer to the Danish coast, which was probably caused by the wind and the currents. These changes caused thereby likewise open out a wide field for observations."

It is hoped that these few remarks may cause renewed observations and investigations relative to the mode of life and the birth and development of the eel.

BERLIN AQUARIUM.

XL.—CHROMATOPHAGUS PARASITICUS—A CONTRIBUTION TO THE NATURAL HISTORY OF PARASITES.*

By Dr. C. Kerbert.

During the last few months my attention has been directed to a skin disease, which at first threatened to become epidemic, and which affected certain freshwater fishes in the Amsterdam Aquarium. Our representatives of *Tinca vulgaris* Cuv. (in fact *Tinca vulgaris* var. *aurata*, or *Tinca chrysitis* Agass.), *Abramis brama* Linn., *Blicca björkna* Siebold, *Cyprinus carpio* Linn., with the two varieties *Cyprinus rex cyprinorum* and *Cyprinus nudus*, *Carassius vulgaris* Kröyer, *Idus melanotus* var. *miniatus* Heck. and Knerr, *Trutta salar* Linn., *Trutta fario* Linn., and finally *Salvelinus fontinalis* Mitchill, showed all over their skin, but principally about the fins and the head and occasionally about the eyes, small but very distinct milk-white round spots the diameter of which varied from 0.25 to 0.6 millimeter. When these spots were examined microscopically, it soon became apparent that they were caused by infusoria, distinguished by their enormous size. The cause of the disease, therefore, was evident. The disease with which we have to deal here is generally termed "spot-disease" (*Fleckenkrankheit*) by ichthyologists and fish-culturists.

In my opinion this so-called "spot-disease" must not be confounded with phenomena observed in various other different cyprinoids by Wittmack[1] and other naturalists, where, on the surface of the skin, there appear bluish-gray spots of a slimy, fungus-like character, which spread more or less over the entire body, and extend to the eyes, fins, &c. This disease is termed *Pocken-Krankheit*, or "pox," by Wittmack. In his excellent work Wittmack says that possibly the real cause of the disease might be traced to infusoria. I must state, however, that in my examinations of fish afflicted with this disease I have so far not discovered any infusoria. When I examined a *Leuciscus erythrophthalmus* Linn., caught in one of the Amsterdam docks on March 31, which was

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* "*Chromatophagus Parasiticus. Ein Beitrag zur Parasitenlehre.*" Von *Dr. C. Kerbert.* Amsterdam, April 9, 1884. Translated from the German by Herman Jacobson.

[1] Dr. L. Wittmack: "*Beiträge zur Fischereistatistik des Deutschen Reichs,*" IV, Diseases of Fish, in Circular of the German Fishery Association, 1875, p. 187.

suffering from this so-called "pox," I found that the latter was a local thickening of the epidermis, a condition of things to which Von Siebold[2] had first called attention. During the spawning season such thickenings of the skin are frequently observed in male cyprinoids, particularly on the head, the cheeks, and the gills, resembling whitish wart-like protuberances. This, of course, does not exclude the possibility that such thickenings of the epidermis, under certain hitherto unknown circumstances, may develop as actual pathological growths.

On the other hand the "spot-disease," *i. e.*, the appearance of white or bright spots on the epidermis of fishes, is invariably caused by animal parasites, in fact by infusoria. This "spot-disease" will make its appearance not only among freshwater fishes, but also among those living in salt water. When I examined a *Mustelus vulgaris* Müll. and Henle, and an *Acanthias vulgaris* Risso, both afflicted with this disease, I found the cause of the spots to be infusoria which, living in the pulp-cavity of numerous placoid scales, had absorbed their contents, pigment cells, &c., as nutriment, and had consequently produced colorless patches on the skin. The rapid decay of the fish unfortunately prevented me from making a more thorough examination of this species of infusorians.

Hilgendorf and Paulicki, of Hamburg, were the first to report the existence of infusoria as parasites on the skin of freshwater fishes.[3] In the aquarium of the Hamburg Zoological Garden the "appearance of slimy excrescences, finally assuming a fungus-like appearance, and causing the death of the fish," was observed in 1868 in many different kinds of fishes in the freshwater tanks. The above-mentioned naturalists discovered in the epidermis, which had become thickened owing to the fungus-like growth, small infusoria, measuring about 0.5 millimeter in diameter, which at first were only considered as occurring casually, but which, on closer examination, were found to be the cause of the disease. Hilgendorf and Paulicki could not discover in these infusoria either a mouth or cilia of any considerable size, or any characteristic shape of the body. The cuticle was covered with very fine evenly-developed cilia, arranged in long, gently-curved lines standing close together. All that could be recognized in the body was a nucleus (in large specimens having the shape of a horseshoe), the contractile vesicle, vacuoles, and granules. According to Hilgendorf and Paulicki, these infusoria appertain to a genus termed by Ehrenberg *Pantotrichum*. In some of them, which had gathered at the bottom of a glass vessel, the process of fission was observed. In my opinion Hilgendorf and Paulicki very correctly consider the appearance of the infusoria as the primary, and the development of fungus as the secondary, process.

This entire process resembles very strongly another phenomenon ob-

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[2] Von Siebold: "*Die Süsswasserfische von Mittel-Europa.*" Leipsic, 1863, p. 89.

[3] Dr. F. Hilgendorf and Dr. A. Paulicki: "*Infusionsthiere als Hautparasiten bei Süsswasserfischen,*" in *Centralblatt für die Medicinischen Wissenschaften*, 1869, No. 3, p. 33.

served in 1876 by D. Fouquet[4] in trout fry in the fish-cultural tanks of the College of France. For about ten years an epidemic was raging among the young individuals of *Trutta fario* L. contained in said tanks, "caused by the presence of infusoria," described in a treatise by Fouquet. It will be necessary to enter more fully into this investigation which Fouquet made, under the direction of Balbiani, because many of the phenomena described by him are closely analogous to those observed by me, while on the other hand there are many points in Fouquet's treatise which can in no way be harmonized with my observations.

The symptoms of the disease in the case observed by Fouquet doubtless agree with those described by Hilgendorf and Paulicki, as observed by them in the Hamburg Aquarium, and those recently observed by me.

Fouquet likewise observed on the skin, fins, eyes, and gills very distinct round milk-white spots, having a diameter of from 0.3 to 0.8 millimeter. A microscopical examination showed that each spot had been caused by the presence of a ciliated infusorian. While Hilgendorf and Paulicki state distinctly that "the epithelium, without exhibiting any other changes, forms a considerable protuberance over the parasite," Fouquet[5] has observed that "the skin is covered with a viscous layer, and that the cells of the epithelium have changed." Sometimes Fouquet finds two or three infusoria of the same or different size in the same cyst, and states distinctly that the form of the young individuals of these infusoria differs from that of the grown individuals.

The former, he says, are "longer," and the latter "more globular." The cuticle is very elastic, transparent, tolerably tough, and covered with very fine cilia, "presenting everywhere the same length, and running in lines which are twisted in spirals and cross each other." The cortical layer [ectosarc] is pale, forms "a white band," and contains scarcely visible trichocysts and numerous contractile vacuoles. The endoplasm is granular and is not stained by carmine. It contains "blackish pigment spots of irregular shape," which, however, do not occur in all cases. At the anterior pole Fouquet observed a small round opening, measuring 0.04 millimeter in diameter, surrounded by much larger and thicker cilia than are found on other parts of the surface of the body, radiating from the periphery toward the center. Below this there is a small cavity terminating in a cul-de-sac, and formed by a transparent membrane. Fouquet states further in a very emphatic manner that this orifice is not the mouth opening, but that it is rather "a modified mouth, transformed into a sucking-disk." In proof of this strange assertion, he states that he never found solid food inside

[4] D. Fouquet: "*Note sur une espèce d'infusoires parasites des poissons d'eau douce,*" in *Archives de Zoologie expérimentale*, published by Henri de Lacaze-Duthiers, vol. v, 1876, p. 159.

[5] Fouquet, I, p. 34.

the body, and that he had never succeeded in making these infusoria absorb carmine. Fouquet therefore supposes that this apparent opening is an apparatus used by the infusoria for adhering to other objects, and that food is absorbed only by an endosmotic process, as in *Ophalina*. So far, however, it has remained utterly incomprehensible to me how a parasite living between the epidermis cells of a fish, which has therefore no immediate access to liquid food, could absorb food by an endosmotic process.

After Fouquet has mentioned the horseshoe-shaped nucleus, he gives a full description of the mode of reproduction of these infusoria. The fully developed individuals go through a process of encystation, and ultimately of fission, which, after three or four days, results in the production of numerous small infusoria (0.046 millimeter long and 0.028 millimeter broad). The sarcode of these young infusoria is not of a granular character, and they possess no sucking-disk. Whether instead of this apparatus these young individuals have a mouth opening, or what changes the anterior pole of the body undergoes during its further development—in what way, that is, the sucking-disk develops in the grown animals—all these are important questions which present themselves to the reader of Fouquet's treatise, but which he leaves entirely unanswered.

Fouquet states, in conclusion, that in the fish-cultural tanks of the College of France this infusorial disease affects the young trout only during three months of the year, from the end of May till some time in August. The young trout became completely emaciated, the epidermis formed became thickened at certain points in which the infusoria were gathered; finally, fungi began to form, and soon death came. Fouquet thinks that a higher temperature of the water, and an increased supply of the same, favor the development of the infusoria. When, in 1876, the hatching troughs received their water from another source, the disease, and with it the infusoria, disappeared.

Fouquet finally discusses the question as to the place to be assigned in the system to these infusoria. In view of their structure and shape, manner of propagation, and anatomical differences between the young and the grown individuals—all of which differ greatly from anything observed in other infusoria—Fouquet assigns to this infusorian a special place, and calls it *Ichthyophthirius multifiliis*, grouping it with the heterotrichous infusoria.

As a third communication relative to the occurrence of infusoria on the skin of fishes, we must mention a statement made by Livingston Stone,[6] who, in the work referred to, takes great pains to describe a parasite on the skin of *Trutta fario* L., which, in the spring of 1872, made its appearance in his hatcheries in vast numbers. The description, however, is so superficial, so vague in every respect, that I find it

[6] Livingston Stone: "Domesticated Trout: How to breed and grow them." 3d edition. Charlestown, N. H., 1877, p. 277. (Appendix I. A new discovery.)

utterly impossible to determine whether the parasites in question are really infusoria. To judge from the very primitive wood-cuts accompanying the article, the parasites may have been *Rotifera*, and in all probability were merely worm-shaped atrochous rotifers, belonging to the genus *Albertia* Duj.,[7] or *Balatro* Clap.,[8] or perhaps to *Dictyophora* Leidy.[9]

Von La Valette St. George[10] mentions the articles by Hilgendorf and Paulicki, and by Livingston Stone, but makes no further statement relative to the occurrence of infusoria as skin parasites.

In the most recent and very extensive work on infusoria, by Saville Kent,[11] this naturalist in speaking of the distribution of the infusoria (vol. i, p. 109) mentions also those forms which so far have been known to zoologists as endo parasites, or ecto-parasites; among the rest, the *Ichthyophthirius multifiliis* described by Fouquet in his article referred to above.

In the "Systematic description of the Infusoria-ciliata"[12] Saville Kent mentions this infusorian, and on the basis of Fouquet's observations establishes among the infusoria-ciliata a new family for the *Ichthyophthirius multifiliis*, which he calls the *Ichthyophthiriidæ* Saville Kent, distinguishing this from the other families by the following:

"*Fam. VIII. Ichthyophthiriidæ* S. K.—Animalcules adherent, more or less ovate, ciliate throughout, oral cilia of larger size than those of the general cuticular surface, oral region adhesive, acetabuliform."

Saville Kent, however, establishes this new family of ciliates with an expressed reservation, which I can very well understand. He very justly remarks[13] that the presence of a sucking-disk and the absence of a mouth opening in these infusoria are points by no means certainly determined. For physiological reasons the absence of a mouth opening is characteristic only of endo-parasites, as is very distinctly shown by the different species of *Opalina*. The occurrence of spots of a blackish color[14] in the body substance sufficiently opposes the opinion entertained by Fouquet, that there is no oral opening. In all probability these black spots were nothing but granules of figment from the epidermis of the fish.

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[7] Dujardin: "*Histoire naturelle des Infusoires.*" Paris, 1841, p. 653.

[8] Claparède: "*Miscellanées zoologiques,*" in *Annales des Sciences Naturelles*, vol. viii, 1867.

[9] Leidy: "Retifora without rotatory organ," in Proceedings Acad. Phil., 1882, pp. 243-250.

[10] V. La Valette St. George: "*Ueber die Feinde der Fische,*" in Circular of the German Fishery Association, 1879, p. 77.

[11] W. Saville Kent: "A Manual of the Infusoria, including a description of all known Flagellate, Ciliate, and Tentaculiferous Protozoa, British and foreign." London, 1880-'82. Vols. i, ii (text), and iii (plates).

[12] Saville Kent, vol. ii, p. 530.

[13] Saville Kent, p. 531.

[14] Fouquet, p. 160.

Farther on we shall have occasion to refer again to Fouquet's investigations and the new family of *Ciliata* established by Saville Kent, and we now return to the infusorian discovered by me. As has already been mentioned, we observed on the skin of various freshwater fishes in our aquarium—principally on the fins and the head, sometimes also on the eyes and on the opercula—very distinct milky-white round spots, whose diameter varied from 0.25 to 0.6 millimeter. Microscopic investigation of these spots showed that they were due to the presence of large infusoria, whose form and structure I have endeavored to represent in Fig. 1, drawn from life. These infusoria were found on or in the epidermis, and showed between the epidermic cells a very distinct rotating motion, either from right to left or from left to right. Although in most cases a single white spot on the skin of the fish indicated the presence of a single infusorian, I observed in some rare cases two, three, or more infusoria imbedded in the epidermis close by each other. The shape of the infusoria was in most cases oval, with a long diameter of 0.615 millimeter, and a short diameter of 0.408 millimeter. The globular individuals, which were much rarer, had a diameter of 0.514 millimeter. I must state, however, that I also observed a number of much smaller individuals.

The body is inclosed in a thin, tender, elastic cuticle, covered all over with very fine cilia, about 0.0046 millimeter in length. The layer below the cuticle is finely granular, with a large number of contractile vacuoles of different sizes. Even with the aid of the highest powers of the microscope I have not been able to discover any trichocysts. Even in the live animal the strangely bent nucleus is seen very distinctly shimmering through the plasma of the body (Figs. 1, 2, 3); but when the infusoria have been killed by osmic acid (½ per cent), and are then treated according to the well-known method of Certes,[15] the horseshoe-shaped nucleus in the largest individuals shows a beautiful red color, and a transverse diameter of 0.139 millimeter (Fig. 4). This nucleus consists of a coarsely granular substance and is enveloped in a very delicate membrane, which appears very distinctly in individuals which for some hours have been kept in a glass cell. I have not noticed a nucleolus in any of the individuals examined by me.

The endoplasm proper contains a large number of granules and particles of different size; and in most individuals—and this is important—there may be observed very distinctly larger or smaller heaps of pigment granules which show a very striking resemblance to the granules found in the pigment cells and chromatophores of the epidermis of fish. The plasmic contents of these infusoria at any rate contained many small particles, which, as I suppose, can only have entered the endoplasm from without. This supposition was confirmed by the discovery of a very distinct oral opening with a well-developed gullet, which was

[15] A. Certes: "*Sur une méthode de conservation des Infusoires,*" in *Compt. Rend. Ac. de Sc.*, Paris, 1879, vol. 88, pp. 433-436.

always found in a somewhat lateral position at the anterior pole of the body. This oral opening (Fig. 1) is circular, surrounded by an annular thickening of the cuticle, and has, according to the size of the individual, a diameter of 0.025 to 0.04 millimeter. The annular thickening of the cuticle which surrounds the oral opening proper bears a wreath of somewhat longer and stiffer cilia than are found on the rest of the surface of the cuticle.

The length of the gullet is about 0.02 millimeter, and its diameter about 0.01 millimeter. The inner end of the gullet, which is directed toward the endoplasm of the body, was slightly bent. Its entire inner surface is covered with long, active cilia, the free ends of which are directed toward the oral opening and protrude a little beyond it. These infusoria have no well-defined opening serving as an anus, and, as I have very distinctly observed, the feces are expelled from various parts of parts of the body.

After having given my observations on the structure of these infusoria, I must call attention to the shape of the body, or rather to the extreme variability of its form, in the individuals which have been removed from the epidermis of the fish. If the infusoria are put in a glass vessel, the shape of the body of the different individuals shows such great differences that at first it seems hardly possible that they belong to one and the same species. The body appears to be extremely metabolic (Fig. 2). Folds, emarginations, and projections appear in one place and disappear in another; so much so that one feels inclined to think that the organism is not an infusorian but an amœba. In fact, I once observed an individual (Fig. 3) that was retort-shaped and had a neck, at the free end of which the oral opening and the gullet could be distinctly recognized.

In conclusion, I must discuss more fully the propagation of these infusoria. From the beginning of my observations it struck me that the individuals that, for the purpose of closer examination, were removed from the epidermis of the fish never showed the slightest indication of the process of fission; and any other mode of reproduction of these infusoria living in the epidermis seems hardly possible. During my observations conducted in the daytime I have never noticed the phenomenon of fission. I consequently arrived at the supposition that possibly propagation by fission might take place during the evening, or even during the night, on the epidermis of the fish. I therefore examined the infusoria removed from the epidermis for several hours after sundown, constantly taking new individuals from the epidermis and subjecting them to a very thorough examination under artificial light in Engelmann's live-box. The result, however, was a negative one, and no sign of a process of fission could be detected. In order to convince myself whether such a process actually took place by night, on March 16 and 17 I took from a *Tinca vulgaris* Cuv., to which a large number of infusoria adhered, some infusoria every hour of the night,

and immediately fixed them in the picro-carmine solution, as given by Certes,[16] with a very weak solution of osmic acid ($\frac{1}{5}$ per cent). The individuals which in this manner had been collected all through the night were examined on the following day, but with the same result. Even in these individuals no process of fission had taken place.

These results were all the more astonishing, as invariably individuals of greatly differing dimensions were found on the epidermis, which circumstance could be explained only by the supposition that the smallest individuals had reached the epidermis from the outside. I now examined very carefully the bottoms of the small aquariums which had been provided for the fish experimented with. The bottoms and the glass walls of the aquariums were thickly covered with these infusoria, but even among these I could not, at least by daylight, find any indications of a process of reproduction by fission. The case was different, however, with these infusoria after sundown. During four evenings I examined the infusoria at the bottom of the aquarium with my microscope by artificial light, and obtained positive results, which were the same every evening. I take the liberty to give below the results of these investigations:

7 p. m. The infusoria became encysted on the bottom of the aquariums. Some of these encysted forms lay entirely motionless in the cyst, while others showed very distinct cilia and were observed to be rotating actively (Fig. 5). Temperature of the water, 8°.5 C. [=47°.3 Fahr.].

7.45 p. m. Most of the encysted forms were in process of fission or division; or the fission had already taken place (Fig. 6). No division of the nucleus could be observed; only once I saw a long nucleus-like body lying perpendicularly to the plane of cleavage of the two individuals.

8.45 p. m. The encysted individuals were segmenting into four parts (Fig. 7).

9.35 p. m. In most of the cysts eight individuals were observed, which, as in the previous stages, were swimming about in the cyst in a lively manner (Fig. 8).

10.15 p. m. The process of cleavage, or fission, had progressed so far that cysts with 16, 32, and even more individuals were very frequent.

11.15 p. m. The different cysts were filled with a large number of very small active individuals. Generally after about ten minutes the cyst burst, and the young infusoria were set free from it. The size of these small individuals was as follows: Long diameter 0.0816, and short diameter 0.0612 millimeter. Temperature of the water, 8.5 degrees C.

In Fig. 9 I give an illustration of this last stage of their development, which closely resembles the so-called "Morula" stage of the *Metazoa*, the figure being drawn from a picro-carmine preparation.

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[16] Certes, p. 435.

From the foregoing observations upon the propagation of these infusoria the following conclusions may be drawn: In the first place, it should be stated that propagation never takes place as long as the infusoria are still lodged in the epidermis of the fish. After the infusoria have reached a certain size by absorbing food, which consists principally of pigment cells, they leave the epidermis, swim about in the water for some time, settle at the bottom, become encysted, and finally undergo a process of fission, which, however, takes place only in the dark. In about five hours this process of fission has been completed, and the young infusoria leave the cyst. These young infusoria now seek the epidermis of some fish in order to go through the same development which we have observed and which we have endeavored to describe above. Occasionally I found among the larger individuals on the skin of the fish very small ones, which were exactly of the same size as those which had just left the cyst. I have never been able to observe any other process of propagation in the free-swimming individuals than that by fission.

In conclusion, I must add a few remarks as to the place in our zoological system which will eventually be occupied by this infusorian. Judging from the phenomena observed by Fouquet in *Ichthyophthirius multifiliis* and described above, I think that I am not in error when I express the belief that the infusoria observed by me in our aquariums belong to the same species as those discovered by Fouquet in the tanks of the College of France on the skin of *Trutta fario* L. My reasons for this are: (1) on account of the agreement in the mode of life of the two forms; and (2) on account of the very striking similarity of their structure and mode of propagation. There is, however, still a wide gap between the *Ichthyophthirius multifiliis* Fouquet, and the infusorian described by me, namely, the absence of an oral opening, the occurrence of a sucking-disk, and the stable form of the body of the first-mentioned species; and, on the other hand, the occurrence of a distinct oral opening and the complete absence of a sucking-disk in the form observed by me, the mass of the body of which is, moreover, metabolic to a high degree.

Further investigations must show whether this supposition of mine is well-founded, and whether Fouquet, when he says that his *Ichthyophthirius multifiliis* has no oral opening, but a sucking-disk, has not perhaps been the victim of an optical delusion. As has already been stated, Saville Kent has likewise expressed a similar opinion grounded upon physiological reasons.

With the aid of all the literature on infusoria which was at my disposal, especially Saville Kent's classical work, I have in vain endeavored to find the position in the system of the infusorian observed by me. As to its structure it resembles most those infusoria which Saville Kent places in the family of the *Trachelocercidæ*[17] among the *Ciliata-Holo-*

[17] Saville Kent, p. 509.

tricha. As in those, the more or less elongated or flask-shaped body is covered entirely with cilia, which around the oral opening are somewhat (but very little) longer than those found on other parts of the body; the cuticle is very delicate and flexible, the position of the oral opening is subterminal, and the anterior part of the body may at times be extended like a proboscis.

Although this infusorian may be placed in the family of the *Trachelocercidæ*, it is more difficult as to which one of the known genera of this family it belongs. While this infusorian differs essentially from *Trachelocerca* Ehr., *Lacrymaria* Ehr., *Phialina* Ehr., and *Maryna* Gruber, by the entire absence of anything like an anterior head-like differentiation, it is on the other hand impossible to place it under *Lagynnis* Quennerstedt, or *Chœnia* Quenn., because the gullet is not plicate, and because the oral opening is always distinctly visible.

I therefore feel compelled to erect a new genus for the reception of the species described by me, and propose the name *Chromatophagus*, therefore incorporating this animal into the system as *Chromatophagus parasiticus*, gen. et spec. nov.

If future investigations should show that the views expressed above by me, regarding the observations and opinions of Fouquet relative to his *Ichthyophthirius multifiliis*, are correct, it becomes evident in that event that the new family of the *Ichthyophthiriidæ* for the reception of Fouquet's species established by Saville Kent must be abandoned and eliminated from among the families of the *Ciliata-Holotricha*.

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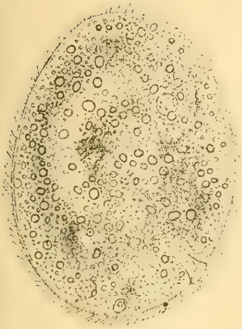

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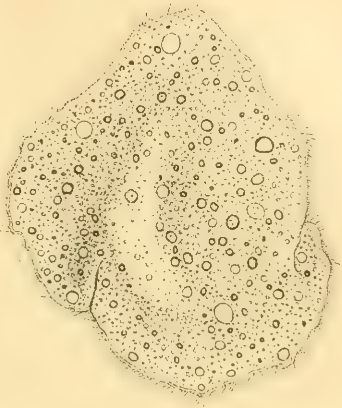

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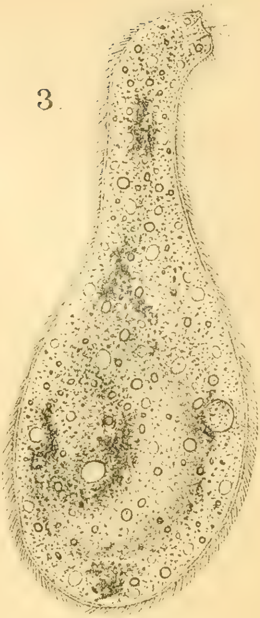

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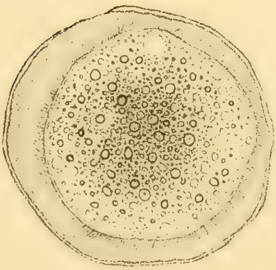

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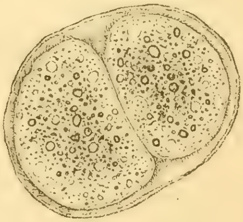

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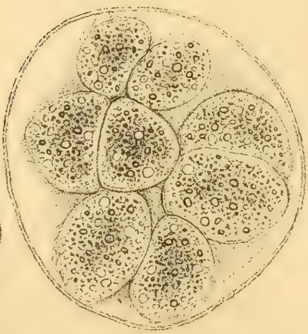

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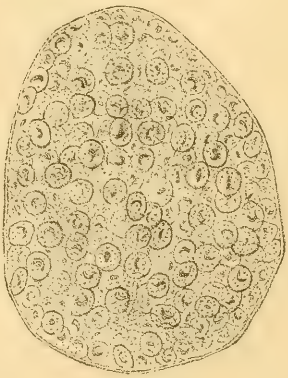

APPENDIX E.

MISCELLANEOUS.

XLI.—THE STATUS OF THE U. S. FISH COMMISSION IN 1884.

BY G. BROWN GOODE,
Assistant Director of the U. S. National Museum.

ANALYSIS.

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1. INTRODUCTORY NOTE.

In an essay entitled "Epochs in the History of Fish Culture," published in the Transactions of the American Fish Cultural Association for 1881 (tenth meeting, pp. 34–59), in a paper on "The First Decade of the United States Fish Commission," read before the American Association for the Advancement of Science in 1880 (proceedings Boston meeting, pp. 563–574), in the article "Pisciculture," in the forthcoming Volume XIX of the "Encyclopædia Britannica," in a paper not yet

published upon "The Aims and Limitations of Modern Fish Culture," recently presented to the Biological Society of Washington, and in an address upon "The Fishery Industries of the United States," delivered June 25, 1883, at the London Fisheries Exhibition, the writer has considered from various points of view the history of fish culture in America, and, what constitutes a very considerable part of this topic, the history of the United States Fish Commission. It is proposed in this essay to bring the discussion down to the present time, and to show, by quotations from recognized Old-World authorities, that the opinions which the writer has expressed in the past and now reaffirms are shared by others who have better right to opinions than he.*

2. THE ESTABLISHMENT OF THE U. S. FISH COMMISSION.

On the 9th of February, 1871, Congress passed a joint resolution which authorized the appointment of a Commissioner of Fish and Fisheries. The duties of the Commissioner were thus defined: "To prosecute in-

* It has been the good fortune of the writer to be intimately acquainted with the work of the United States Fish Commission ever since its organization, and to have served in its ranks as a volunteer upon many occasions. In 1871 a private natural history excursion on the coast of Southern Massachusetts afforded the opportunity of inspecting the work, then in its first year's organization, from the outside. In 1872 and 1873, at Eastport and Portland, as an officer of a New England college; in 1874, at Noank; in 1875, at Wood's Holl, working in behalf of the Government Board of the Centennial Exhibition; in 1877, as statistical expert in behalf of the State Department, at Halifax; in 1878, in behalf of the National Museum, at Gloucester, he was one of the party at the coast stations, taking more or less active part in the marine explorations, according as his other engagements would permit. From 1879 to the beginning of 1881 he was in the employ of the Superintendent of the Tenth Census, in charge of the division of fishery statistics. Since 1875 the Commissioner of Fisheries has from time to time intrusted him with the conduct of special investigations, the results of which have been published in the official reports. In 1880 at the International Fisheries Exhibition in Berlin, and in 1883 upon a similar occasion at London, it was his privilege, through Presidential appointment, to represent in the capacity of United States commissioner the fishery interests of the nation, including the work of the United States Fish Commission and the fish commissions of the several States. During these fourteen years of relationship to the work he has never held any direct official relationship to the Commissioner of Fisheries, nor, so far as he can remember, has he ever received a week's salary from the Fish Commission appropriation; his connection with the work having always been that of a volunteer, except so far as his duties in connection with the National Museum, Census, State Department, or the various international exhibitions have carried him into the routine of the Commission work.

These facts are mentioned simply to explain the stand-point from which it is proposed in this review, to consider the career of the Commission, this stand-point being that of an outside observer, whose work for some time past has been entirely separate from that of the Commission, but who, by reason of his familiarity with the history and interior workings of the service, is an enthusiastic supporter of, and believer in, the work, and who has had opportunities to observe what European Governments have done in their efforts to grapple with the fisheries problem, and how the operations of our Government are looked upon by the statesmen and economists in other lands.

vestigations on the subject (of the diminution of valuable fishes) with the view of ascertaining whether any and what diminution in the number of the food-fishes of the coast and the lakes of the United States has taken place; and, if so, to what causes the same is due; and also whether any and what protection, prohibitory or precautionary measures should be adopted in the premises, and to report upon the same to Congress."

The resolution establishing the office of Commissioner of Fisheries required that the person to be appointed should be a civil officer of the Government, of proved scientific and practical acquaintance with the fishes of the coast, to serve without additional salary. The choice was thus practically limited to a single man, for whom, in fact, the office had been created. Professor Baird, then Assistant Secretary of the Smithsonian Institution, was appointed and entered at once upon his duties.

I think I may say without fear of challenge that very much of the improvement in the condition of our fisheries has been due to the wise and energetic management of our Commissioner. Himself an eminent man of science, for forty years in the front rank of biological investigation, the author of several hundred scientific memoirs, no one could realize more thoroughly the importance of a scientific foundation for the proposed work.*

His position as the head of that most influential scientific organization, the Smithsonian Institution, given by an Englishman to the United States "for the increase and diffusion of useful knowledge among men," enabled him to secure at once the aid of a body of trained specialists.

Pure and applied science have labored together always in the service of the Fish Commission, their representatives working side by side in the same laboratories; indeed, much of the best work both in the investigation of the fisheries and in the artificial culture of fishes has been performed by men eminent as zoologists.

The principal activity of the Commissioner, however, has been directed to the wholesale replenishment of our depleted waters. The success of fish culture is well recognized in the United States, but it was especially gratifying to its advocates that in 1880 the grand prize of the International Fisheries Exhibition at Berlin was awarded to Professor Baird as "the first fish-culturist in the world."

3. THE SCOPE OF ITS WORK.

The work of the Commission is naturally divided into three sections:

1. The systematic investigation of the waters of the United States and the biological and physical problems which they present. The scientific studies of the Commission are based upon a liberal and philo-

*See the recently published "Bibliography of the writings of Spencer Fullerton Baird" (Bulletin 20, United States National Museum), in which are enumerated the scientific papers of this investigator, not a small number of which relate directly to fishery economy.

sophical interpretation of the law. In making his original plans the Commissioner insisted that to study only the food-fishes would be of little importance, and that useful conclusions must needs rest upon a broad foundation of investigations purely scientific in character. The life history of species of economic value should be understood from beginning to end, but no less requisite is it to know the histories of the animals and plants upon which they feed or upon which their food is nourished; the histories of their enemies and friends and the friends and foes of their enemies and friends, as well as the currents, temperatures, and other physical phenomena of the waters in relation to migration, reproduction, and growth. A necessary accompaniment to this division is the amassing of material for research to be stored in the National and other museums for future use.

2. The investigation of the methods of fisheries, past and present, and the statistics of production and commerce in fishery products. Man being one of the chief destroyers of fish, his influence upon their abundance must be studied. Fishery methods and apparatus must be examined and compared with those of other lands, that the use of those which threaten the destruction of useful fishes may be discouraged, and that those which are inefficient may be replaced by others more serviceable. Statistics of industry and trade must be secured for the use of Congress in making treaties or imposing tariffs, to show to producers the best markets, and to consumers where and with what their needs may be supplied.

3. The introduction and multiplication of useful food-fishes throughout the country, especially in waters under the jurisdiction of the General Government, or those common to several States, none of which might feel willing to make expenditures for the benefit of the others. This work, which was not contemplated when the Commission was established, was first undertaken at the instance of the American Fish Cultural Association, whose representatives induced Congress to make a special appropriation for the purpose. This appropriation has since been renewed every year on an increasingly bountiful scale, and the propagation of fish is at present by far the most extensive branch of the work of the Commission, both in respect to number of men employed and quantity of money expended.

The origin of the Commission, its purposes, and methods of organization, having been described, it now remains to review the accomplished results of its work. In many departments, especially that of direct research, most efficient services have been rendered by volunteers; in fact, a large share of what has been accomplished in biological and physical exploration is the result of unpaid labor on the part of some of the most skillful American specialists. Although I should be glad to review the peculiar features of the work of each investigator, the limits of this paper will not allow me even to mention them by name

4. METHODS AND RESULTS OF THE COAST INVESTIGATION.

Since the important sea fisheries are located along the North Atlantic, the coast of this district has been the seat of the most active operations in marine research. For twelve years the Commissioner, with a party of specialists, has devoted the summer season to work at the shore, at various stations along the coast, from North Carolina to Nova Scotia.

A suitable place having been selected, a temporary laboratory is fitted up with the necessary appliances for collection and study. In this are placed from ten to twenty tables, each occupied by an investigator, either an officer of the Commission or a volunteer.

The regular routine of operations at a summer station includes all the various forms of activity known to naturalists—collecting along the shore, seining upon the beaches, setting traps for animals not otherwise to be obtained, and scraping with dredge and trawl the bottom of the sea, at depths as great as can be reached by a steamer in a trip of a few days. In the laboratory are carried on the usual structural and systematic studies; the preparation of museum specimens and of reports.

In addition to what has been done at the summer station, more or less exhaustive investigations have been carried on by smaller parties in every important position of the coast and interior waters.

For several years steamers were lent for the work for a greater or less period of time by the Coast Survey and the Revenue Marine services, and in and subsequent to 1873 by the Navy Department.

In 1880, however, a steamer of 450 tons, the Fish Hawk, was built for the fish-hatching purposes of the Commission. Another larger steamer, of 1,000 tons, the Albatross, was built and put into commission in 1883 for special service in connection with the sea fisheries.

Through the courtesy of the Secretary of the Navy and in direct compliance with the law of Congress, naval officers have been detailed to attend to the technical details of the deep-sea work—a course mutually beneficial to the two services, since the appropriation of the Fish Commission is thereby husbanded, and an efficient staff of navigators is insured, while active employment and training in scientific methods of work is provided for several naval officials.

One of the important features of the work done by the Commission has been the preparation of life histories of the principal fishes, great quantities of material having been accumulated relating to almost every species. A portion of this has been published, biographical monographs having been published on the bluefish, the scup, the menhaden, the salmon, the whitefish, the shad, the mackerel, the swordfish; and the others will make up the first volume of the forthcoming illustrated special report upon the fisheries and fishery industries of the United States, now in the hands of the Public Printer.

In connection with the work of fish culture much attention has been paid to embryology. The breeding times and habits of nearly all of our

fishes have been studied, and their relations to water temperatures. The embryological history of a number of species, such as the cod, shad, alewife, salmon, smelt, Spanish mackerel, striped bass, white perch, the silver gars, the clam, and the oyster have been obtained under the auspices of the Commission.

Many other problems have been worked out by specialists for the Commission, the details of which are described in the reports. One of these, for instance, has been the determination of the cause of the reddening of salt codfish, so injurious to commerce. Professor Farlow found this to be due to the presence of a species of alga in the kind of salt in common use, and gave instructions by which the plague has been greatly lessened.

An investigation into the chemical composition and nutritive value of fish as compared with other food is still in progress, and all American food-fishes are being analyzed by Professor Atwater.

The temperature of the water, in its relation to the movements of fish, has from the first received special attention. Observations are made regularly during the summer work, and at the various hatching stations. At the instance of the Commissioner, an extensive series of observations has for several years been made under the direction of the Chief Signal Officer of the Army and with the hearty co-operation of the Light-House Board at light-houses, light-ships, life-saving and signal stations, carefully chosen, along the whole coast. A number of fishing schooners and steamers have kept similar records. One practical result of the study of these observations has been the demonstration of the cause of the failure of the menhaden fisheries on the coast of Maine in 1879—a failure on account of which nearly two thousand persons were thrown out of employment; and a similar course of study recently developed by Colonel McDonald seems to explain the recent fluctuations in the shad fishery.

A most remarkable series of contributions has been received from the fishermen of Cape Ann. When the Fish Commission had its headquarters at Gloucester, in 1878, a general interest in the zoological work sprang up among the crews of the fishing vessels, and since that time they have been vieing with each other in efforts to find new animals. Their activity has been stimulated by the publication of lists of their donations in the local papers; and the number of separate lots of specimens received, to the present time, exceeds eight hundred. Many of these lots are large, consisting of collecting-tanks full of alcoholic specimens. At least thirty fishing vessels were carrying collecting-tanks on every trip, until it became necessary to recall them because no more specimens were required, and many of the fishermen, with characteristic superstition, had the idea that it insured good luck to have a tank on board, and would not go to sea without one. The number of specimens acquired in this manner is at least 50,000 or 60,000, most of them belonging to species unattainable by other means.

The success of the incidental efforts of these men would seem to indi-

cate that much of the coast work of the Fish Commission could be more effectively accomplished by small vessels navigated by skillful fishermen than by large steamers with their more complicated routine.

5. RESULTS OF INQUIRY INTO CAUSES OF FISHERY DETERIORATION.

The investigation of the statistics and history of the fisheries has perhaps assumed greater proportions than was at first contemplated. One of the immediate causes of the establishment of the Commission was the dissension between the line and net fishermen of Southern New England with reference to laws for the protection of the deteriorating fisheries of that region. The first work of Professor Baird, as Commissioner, was to investigate the causes of this deterioration.

Each year increasing attention has been paid to this subject. The Commissioner has never advised any legislation on the part of the General Government, each State government having control over the fisheries in its own waters. Certain general conclusions concerning the effect of the fisheries upon the abundance of aquatic animals, seem to meet with general acceptance in the United States.

The important distinction between *the extermination of a species*, even in a restricted locality, and *the destruction of a fishery*, should be noticed. The former is somewhat unusual, and seemingly impossible in the case of oceanic species, while the latter, especially for limited regions, is almost of yearly occurrence.

1. Aquatic mammals, like seals, may be entirely exterminated, especially when, like the fur-seals, they forsake the water and occupy the land for breeding purposes. The fur-seals of our Pacific coast are nearly gone, except upon the Prybilov Islands of Alaska, where they are protected by the General Government, the islands being leased to a company, which is allowed to kill only 100,000 each year, these being non-breeding males, and the permanence of this fishery thus being perfectly secured.

2. Aquatic mammals which do not leave the water, such as whales and manatees, conspicuous on account of their size, and not capable of rapid multiplication, may be practically exterminated when they breed near the shore. As examples, may be cited the cases of the Arctic sea-cow of the North Pacific, *Rhytina Stelleri*, and the Pacific gray-whale, or devil-fish, *Rhachianectes glaucus*, the tale of whose destruction in the lagoons of California may be found in Scammon's Marine Mammals of the Pacific Coast.

3. In the case of fixed animals, like the sponge, the mussel, the clam, and the oyster, the colonies or beds may be practically exterminated, exactly as a forest may be cut down. The destruction of the oyster beds of Pocomoke Sound, in Maryland, a large estuary, formerly very productive, is an example—the destruction being due more directly to the choking of the beds by the rubbish raked over them by the dredges, and the destruction of the ledges suitable for the reception of the young

spat, than to the removal of all the adult oysters, which was, of course, never effected.

The preservation of the oyster-beds is a matter of vital importance to the United States, for oyster fishing, unsupported by oyster culture, will, within a short period, destroy the employment of tens of thousands, and the cheap and favorite food of tens of millions of our people.

Such transfer has already come to pass in France and Holland, and England, but there appear to be almost unsurmountable difficulties in the way of protecting the property of oyster culturists from depredations—difficulties apparently as formidable in England as in America. Professor Huxley, who views these vexed problems with a vision whose clearness is all the more conspicuous from being brought into juxtaposition with the hazy generalizations of other European fishery officials, has pointed out the fallacy of close-time legislation. "Suppose," he remarks, "that in a country infested by wolves you have a flock of sheep; keeping the wolves off during the lambing season will not afford much protection if you withdraw shepherd and dogs during the rest of the year. * * * Surely nothing is more obvious than this—that the prohibition of taking the oysters from an oyster bed during four months in the year is not the slightest security against its being stripped clean (if such a thing be possible) during the other eight months."

Something may be effected by laws which allow each bed to rest for a period of years after each season of fishing upon it. It is the general belief, however, that shell-fish beds must be cultivated as carefully as garden beds, and that this can only be done by leasing them to individuals. This is already the practice in the Northern States, where oysters are planted in new localities. There is difficulty, however, in carrying out this policy in the case of natural beds, to which the fishermen have had continued access for centuries. It is probable that the present unregulated methods will prevail until the dredging of the natural beds ceases to be remunerative, and that the oyster industry will then be transferred from the improvident fishermen to the care-taking oyster culturists, with a corresponding increase in price and decrease in consumption.

4. Fishes in ponds, lakes, or streams are quickly exterminated unless the young fish are protected, the spawning season undisturbed, and wholesale methods of capture prohibited. Many of our older States now have excellent laws for the preservation of game and fish, which are enforced, not by fishery wardens, but by the agency of societies and anglers' clubs, whose members are expected to prosecute offenders against the public interest.

5. A river may quickly be emptied of its anadromous fishes, salmon, shad, and alewives by overfishing in the spawning season, as well as by dams which cut off the fish from their spawning grounds. Examples of this may be found in dozens of American rivers.

In the same way sea fishes approaching the coasts to spawn upon the

shoals or in the bays may be embarrassed, and the numbers of each school decimated, particularly if, as in the case of the herring, the eggs are adhesive and heavy.

Sea fishes spawning in the estuaries are affected by wholesale capture with stake nets, much in the same manner, though in a less degree, than salmon in the rivers. An example is apparently found in the temporary depression in the scuppaug or porgy fishery of Narragansett Bay.

Our shad and alewife fisheries are protected by an economic code of laws, different in the different States, and in the different rivers of each State. The most satisfactory laws are those which regulate the dates at which fishing must begin and close, and prescribe at least one day in the week, usually Sunday, in which the ascent of the fish must not be interrupted. Massachusetts regulates its stake-net fisheries along the coast in a similar manner.

Migratory, semi-migratory, or wandering fishes, ranging in schools or singly over broad stretches of ocean, mackerel, herring, menhaden, bluefish, bonito or squeteague, are apparently beyond the influence of human agency, especially since they spawn at a distance from the coast, or since the adults, when about to spawn, cannot be reached by any kind of fishery apparatus. Their fecundity is beyond comprehension, and in many instances their eggs float free near the surface, and are quickly disseminated over broad areas. The conclusions gained by Professor Baird tally exactly with those of Professor Huxley, that the number of any one kind of oceanic fish killed by man is perfectly insignificant when compared with the destruction effected by their natural enemies.

Their movements are no more to be anticipated than those of the atmosphere, and in many instances, with no intelligible cause, some of the most abundant species, the bluefish, the chub-mackerel, the little tunny, the scuppaug, and the bonito have absented themselves for considerable periods of years.

The chart showing the history of the mackerel fishery for the past eighty years, hanging in the fisheries gallery of the National Museum, is an illustration of this statement. The variations in abundance cannot be explained by any facts in our possession, and the yield in 1882 was greater than ever before notwithstanding the fact that the fisheries of the past ten years have been prosecuted with unusual vigor. The remarkable change in the habitat of the menhaden, occurring in 1880, and promising to be permanent, was certainly not the effect of overfishing, though fifteen years ago it would have been regarded as such. When the production of a region falls in two successive summers from 617,000 to 550 barrels, it is evident that nature, not man, is the cause.

The variations in the abundance of cod and haddock along the coast and on the banks within the last half century have been equally inexplicable.

Almost any piece of water, be it a bay or sound, or be it the covering of a ledge or shoal at sea, may be overfished to such a degree that fishing becomes unprofitable, especially if fishing be carried on in the spawning season. This statement refers, of course, only to the fishes which feed near the bottom. A familiar example is the abandonment of Massachusetts Bay by the halibut and the extension of the fishery into very deep water.

Protection to the local fishermen may therefore require the regulation by law of definite fishing-grounds near the coast. There can be no doubt that the extensive fisheries prosecuted by menhaden steamers in the gulf of Maine, though probably not so injurious to the fishery interests in general as is usually supposed, were prejudicial to the shore fishermen by driving the fish they formerly caught for bait out to sea and beyond the reach of their nets. There is also reason to believe that our great purse-seine fisheries for menhaden and mackerel, though perhaps not causing a decrease in the numbers of the fish, have kept them farther from the shore.

6. METHODS TO BE ADOPTED FOR THE IMPROVEMENT OF THE FISHERIES.

We have briefly reviewed the character of the various destructive influences which man brings to bear upon the inhabitants of the water, and noticed in passing some of their effects. We now are confronted by the question, What can be done to neutralize these destructive tendencies? There are evidently three things to do:

1. To preserve fish waters, especially those inland, as nearly as it may be possible in their normal condition.
2. To prevent wasteful or immoderate fishing.
3. To put into practice the art of fish breeding:
   a. To aid in maintaining a natural supply.
   b. To repair the effects of past improvidences, and
   c. To increase the supply beyond its natural limits rapidly enough to meet the necessities of a constantly increasing population.

The preservation of normal conditions in inland waters is comparatively simple. A reasonable system of forestry and water-purification is all that is required; and this is needed not only by the fish in the streams but by the people living on the banks. It has been shown that a river which is too foul for fish to live in is not fit to flow near the habitations of man. Obstructions, such as dams, may, in most instances, be overcome by fish ladders. The salmon has profited much by those devices in Europe, and the immense dams in American rivers will doubtless be passable even for shad and alewives if the new system of fish-way construction, devised by Colonel McDonald, and now being applied on the Savannah, James, and Potomac, and other large rivers, fulfills its present promises of success.

The protection of fish by law is what legislators have been trying to effect for many centuries, and we are bound to admit that the success of

their efforts has been very slight indeed. Great Britain has at present two schools of fishery economists, the one headed by Professor Huxley, opposed to legislation, save for the preservation of fish in inland waters, the other, of which Dr. Francis Day is the chief leader, advocating also a strenuous legal regulation of sea fisheries. Continental Europe is by tradition and belief committed to the last-named policy. In the United States, on the contrary, public opinion is generally antagonistic to fishery legislation, and our Commissioner of Fisheries after carrying on for fourteen years investigations upon this very question has not yet become satisfied that laws are necessary for the perpetuation of the sea fisheries, nor has he ever recommended to Congress enactment of any description.

Just here we meet the test problem in fish culture. Many of the most important commercial fisheries of the world, the cod-fishery, the herring-fishery, the sardine-fishery, the shad and alewife fishery, the mullet-fishery, the salmon-fishery, the whitefish-fishery, the smelt-fishery, and many others, owe their existence to the fact that once a year these fishes gather together in closely swimming schools, to spawn in shallow water, on shoals, or in estuaries and rivers. There is a large school of *quasi* economists who clamor for the complete prohibition of fishing during spawning time. Their demand demonstrates their ignorance. Deer, game, birds, and other land animals may easily be protected in the breeding season, so may trout and other fishes of strictly local habits. Not so the anadromous and pelagic fishes. If they are not caught in the spawning season, they cannot be caught at all. I heard a prominent fish culturist recently advocating before a committee of the United States Senate the view that shad should not be caught in the rivers because they came into the rivers to spawn. When asked what would become of our immense shad-fisheries if this were done, he said that doubtless some ingenious person would invent a means of catching them at sea.

The fallacy in the argument of these men lies in part in supposing that it is more destructive to the progeny of a given fish to kill it when its eggs are nearly ripe, than to kill the same fish eight or ten months earlier.

We must not, however, ignore the counter-argument. Such is the mortality among fish that only an infinitesimal percentage attains to maturity. Professor Möbius has shown that for every grown oyster upon the beds of Schleswig-Holstein 1,045,000 have died. Only a very small proportion, perhaps not greater than this, of the shad or the smelt ever comes upon the breeding grounds. Some consideration, then, ought to be shown to those individuals which have escaped from their enemies and have come up to deposit the precious burden of eggs. How much must they be protected?

I quote from the Commissioners Report for 1882, the following memoranda of what the Fish Commission hopes to accomplish in time, in connection with this department of its work.

"1. *In the department of investigation and research there is yet to be carried out an exhaustive inquiry into the character, abundance, geographical distribution, and economical qualities of the inhabitants of the waters both fresh and salt.* The subject is practically unlimited in extent, and, so far as the ocean is concerned, has scarcely been touched. With the powerful apparatus, however, at the command of the Commission, it is expected that much progress will be made year by year, and the publication of the results and the distribution of duplicate specimens to colleges and academies in the United States be carried out on a large scale, so as to meet the increasing demand.*

"2. *The second object in connection with the sea fisheries is the improvement of the old methods and apparatus of fishing and the introduction of new ones.* The work of the Commission in bringing to the notice of American fishermen the importance of gill-nets with glass ball floats for the capture of codfish has already revolutionized the winter codfishery industry in New England. Looked upon almost with ridicule by the Gloucester fishermen when first brought to their notice by the Commission, these nets have come rapidly into use, until at the present time they represent the most important element in the winter fisheries, the number of fish taken being not only much greater but the fish themselves of finer quality."

Between eight and nine millions pounds of codfish were taken in the winter of 1883–'84 about Cape Ann by a fleet of 25 to 30 sail, this being nearly three times what was formerly taken by Cape Ann fishermen in a winter's work of trawl-line fishing, and comparing favorably with the renowned gill-net codfishery of Norway.

"3. *Another important point for consideration is that of the improvement in the pattern of fishing vessels.* There is annually a terrible mortality in the fishing crews of New England, especially those belonging to

*The Commission has made very large collections of aquatic animals, especially of fishes, shells, corals, crustaceans, star-fishes, &c., and after submitting them to a careful investigation for monographic research, and setting aside a full series for the National Museum, the remainder has been made up into well-identified and labeled sets for distribution to colleges, academies, and other institutions of learning throughout the United States. The educational advantages of this last measure have proved to be of the utmost value, and are thoroughly appreciated by teachers throughout the country. Applications for these sets are being continually received, and several hundreds of them have already been supplied, a number of persons being employed for a good part of the time in preparing to meet additional calls. There is nothing which so much increases the interest in natural history as the opportunity of examining actual specimens of rare and usually unprocurable species, instead of depending upon descriptions and drawings; and as the possibility of obtaining these series becomes the better known it is quite likely that all the resources of the Commission for making collections, great as they are, will be fully taxed * * *. There is no nation that does so much as the United States in the way of co-operation with teachers and students, advancing theoretical and practical natural history through its distributions of duplicate specimens and of official documents. (Report of Commission for 1882, p. 1, *et seq.*)

Gloucester, to say nothing of the total loss and wreck of the fishing vessels and their contents. There has gradually developed in connection with the mackerel and cod fisheries of New England a pattern of vessel which, while admirable for speed and beauty of lines and of rig, is less safe under certain emergencies than the more substantial vessel used abroad, especially in England and Scotland. The subject of the best form of fishing vessel has been intrusted Captain Collins, of the Commission, himself a most experienced fisherman, and after a careful study of the boats of all nations he has prepared a model which is believed to combine the excellencies of both English and American vessels. An appropriation will be asked from Congress for means to construct an experimental vessel and test its qualities; but until this successful experiment is made it will be difficult to induce the fishermen to change their present form of construction."

Since this was written some progress has been made to the accomplishment of this end. The model of the "New Era," exhibited at the London Fisheries Exhibition, met with the approval of many experienced builders, yachtsmen, and fishermen, and a tendency is manifesting itself among the New England fishermen to heed the warnings of Captain Collins; a number of somewhat deeper vessels having already been built. It is much to be regretted that Congress failed to make the desired appropriation before their summer adjournment.

"4. *The fourth object of the Commission is to determine the extent and general character of the old fishing localities and to discover new ones.* There is no doubt whatever that there still remains many important areas, even in the best known seas, where the codfish and halibut will be found in their old abundance. There has never been any formal investigation on this subject, and the banks that are known have been brought to light purely by accident. It is believed that by a systematic research and a careful survey, the area of known grounds can be greatly extended. There is even more reason to hope for successful results from this inquiry of the South Atlantic coast and in the Gulf of Mexico. These regions, the latter especially, may be considered as practically unknown, the few established localities for good fishing being in small proportion to what must exist."

A preliminary discussion of the fishing grounds, prepared by Messrs. Rathbun and Collins is now going through the press, and this will give us a foundation for future expansion. It may be mentioned incidentally that during the London exhibition, members of the American staff were enabled to point out from their knowledge of the habits of these fish in the Western Atlantic, the locations of what are no doubt excellent fishing ground for halibut and mackerel along the European coasts which have never been tried by European fishermen.

"5. *There is also much to be learned in the way of curing and packing fish for general and special markets.* The American methods have grown up as a matter of routine, and are adapted to only one class of demand.

There are, however, many modes of preparations which can be made use of to meet the wants of new markets, and thus enter more efficiently into competition with European nations for European trade, as well as for that of the West Indies and Central America. A great advance has already been made toward this desired improvement since the Centennial Exhibition of 1876, where many methods of curing and putting up fish were shown in the foreign sections that were almost entirely unknown in America. Notably among these were the preparation of sardines and other species of herring in oil as well as in spiced sauces. Quite recently this industry has been well established in Maine, amounting to a value of millions of dollars, and there are many other parts of the country where the same work can be done with other kinds of fish."

The fisheries exhibitions of Berlin and London greatly promoted this department of the work. An extensive export trade with the continent was inaugurated at the close of the Berlin exhibition, but was not continued, because of the indifference of our fish merchants to the advantages of a foreign market, their entire capacity being required to manage to supply the home demand. The members of the American staff at these exhibitions have prepared an elaborate report upon the methods of preparing fish for European markets and the opportunity for extend ing our commerce in this direction.

7. THE SCOPE AND PROVINCE OF ARTIFICIAL PROPAGATION.

Here the fish culturist comes in with the proposition "that it is cheaper to make fish so plenty by artificial means, that every fisherman may take all he can catch, than to enforce a code of protection laws."

The salmon rivers of the Pacific slope and the shad rivers of the East and the whitefish fisheries of the lakes are now so thoroughly under control by the fish-culturist that it is doubtful if any one will venture to contradict his assertion. The question now is whether he can extend his domain to other species.

Fish culture in its more restricted sense, or fish breeding, must sooner or later be resorted to in all densely populated countries, for with the utmost protection nature, unaided, can do but little to meet the natural demand for fish to eat. Pond culture, *Teichwirthschaft*, has been practiced for many centuries, and the carp and the goldfish have become domesticated like poultry and kine. The culture of carp is an important industry in China and in Germany, though perhaps not more so than it was in England three and four centuries ago; the remains of ancient fish-stews may be seen upon almost every large estate in England, and particularly in the vicinity of old monasteries. Strangely enough not a single well-conducted carp-pond exists in England to-day to perpetuate the memory of the tens of thousands which were formerly sustained, and the carp escaping from cultivation have reverted to a feral state, and are of little value. Carp culture can never be made to succeed in

England until improved varieties of carp are introduced from Germany, as they have been in this country.

A kind of pond culture appears to have been practiced by the ancient Egyptians, though in that country, as in ancient Greece and Rome, the practice seems to have been similar to that now practiced in the lagoons of the Adriatic and of Greece, and to have consisted in driving the young fish of the sea into artificial inclosures or vivaria, where they were kept until they were large enough to be used.

The discovery of the art of artificially fecundating the ova of fish must apparently be accredited to Stephan Ludwig Jacobi, of Hohenhausen, in Westphalia, who, as early as 1748, carried on successful experiments in breeding salmon and trout.

The importance of this discovery was thoroughly appreciated at the time, and from 1763 to 1800 was a fruitful subject of discussion in England, France, and Germany. George III, King of England, in 1771 granted to Jacobi a life pension. Upon the estate of Jacobi, by the discoverer and his sons, it was carried on as a branch of agriculture for nearly eighty years—from 1741 to 1825—though it was nearly one hundred years before public opinion was ripe for a general acceptance of its usefulness, a period during which its practice was never entirely abandoned by the Germans.

The establishment in 1850 at Huningue, in Alsace, by the French Government of the first fish-breeding station, or "piscifactory," as it was named by Professor Coste, is of great significance, since it marks the initiative of public fish culture. To this establishment the world is indebted for some practical hints, but most of all for its influence upon the policy of governments. The fortunes of war and conquest have now thrown Huningue into the hands of the German Government. The art discovered in Germany was practiced in Italy as early as 1791 by Bufalini; in France in 1820; in Bohemia in 1824; in Great Britain in 1837; in Switzerland in 1842; in Norway, under Government patronage, in 1850; in Finland in 1852; in the United States in 1853; in Belgium, Holland, and Russia in 1854; in Canada about 1863; in Austria in 1865; in Australasia, by the introduction of English salmon, in 1852, and in Japan in 1877.

Sponges have been successfully multiplied by cuttings, like plants, in Austria and in Florida.

Oysters have long been raised in artificial inclosures from spat naturally deposited upon artificial stools. The eggs of the American and Portuguese oysters have at last, however, been artificially fecundated and the young hatched, and in July, 1883, Mr. John A. Ryder, an assistant in the United States Fish Commission, solved the most difficult problem in American oyster culture by devising a mechanical device for preventing the escape of the newly-hatched oysters while swimming about prior to fixation.* The English oyster, being hermaphrodite, or

* Bulletin United States Fish Commission, pp. 17–31, 1884.

monœcious, cannot be artificially propagated from the egg like the diœcious American species.

8. THE METHODS OF ARTIFICIAL PROPAGATION.

The fertilization of the fish egg is the simplest of processes, consisting, as every one knows, in simply pressing the ripe ova from the female fish into a shallow receptacle and then squeezing out the milt of the male upon them. Formerly a great deal of water was placed in the pan; now the "dry method," with only a little, discovered by the Russian, Vrasski, in 1854, is preferred. The eggs having been fertilized, the most difficult part of the task remains, namely, the care of the eggs until they are hatched, and the care of the young fry until they are able to care for themselves.

The apparatus employed is various in principle, to correspond to the physical peculiarities of the eggs. Fish culturists divide eggs into four classes, viz: (1) Heavy eggs, nonadhesive, whose specific gravity is so great that they will not float, such as the eggs of the salmon and trout; (2) heavy, adhesive eggs, such as those of the herring, smelt, and perch; (3) semi-buoyant eggs, like those of the shad and whitefish (*Coregonus*); and (4) buoyant eggs, like those of the cod and mackerel.

Heavy, non-adhesive eggs, are placed in thin layers, either upon gravel, grilles of glass, sheets of wire cloth, or perforated tin, in receptacles through which a current of water is constantly passing. There are numerous forms of apparatus for eggs of this class, but the most effective are those in which a number of trays of wire cloth, just deep enough to carry single layers of eggs, are placed, one upon the other, in a box or jar into which the water enters from below, passing out at the top.

Heavy, adhesive eggs are received upon bunches of twigs or frames of glass plates, to which they adhere and which are placed in receptacles through which water is passing.

Semi-buoyant eggs, or those whose specific gravity is but slightly greater than that of the water, require altogether other treatment. They are necessarily placed together in large numbers, and to prevent their settling upon the bottom of the receptacle it is necessary to introduce a gentle current from below. For many years these eggs could be hatched only in floating receptacles placed in a river with wire-cloth bottoms, placed at an angle, the motion of which was utilized to keep the eggs in suspension. Later an arrangement of plunging buckets was invented, cylindrical receptacles, with tops and bottoms of wire cloth, which were suspended in rows from beams which were worked up and down at the surface of the water by machinery. The eggs in the cylinders were thus kept constantly in motion. Finally the device now most in favor was perfected; this is a receptacle, conical, or at least with a constricted termination, placed with its apex downward, through which passes from below a strong current, keeping the eggs

constantly suspended and in motion. This form of apparatus, of which the McDonald and Clark hatching jars are the most perfect developments, may be worked in connection with any common hydrant.*

Floating eggs have been hatched only by means of rude contrivances for sustaining a lateral circular eddy, or swirl of water, in the receptacle and in floating boxes constructed to utilize the action of the waves.

The use of refrigerators, to retard the development of the egg until such time as it is most convenient to take care of the fry, is now extensively practiced in the United States, and in Germany.

The history of fish culture in this country is so familiar to every one who has the slightest interest in the subject that it seems unnecessary to refer to it in this place, except to show that it was largely to the growth of popular interest in the subject that the Fish Commission has owed its original and since increasing support.

The transplanting of fish was practised and advocated in the United States by General Lincoln, Benjamin Franklin, and others at the close of the last century, and Jacobi, the father of artificial culture, had correspondents in the United States as early as 1770.

For fifteen or twenty years prior to the establishment of the Commission popular interest in the fisheries, and a desire for their maintenance had been on the increase, the state of public opinion being doubtless under stimulation from the action of the French Government in fostering the still infant art of fish culture, which, although discovered before the middle of the previous century in Germany, and never really abandoned in Europe, had not been considered worthy of government aid until the successes of the French peasants, Remy and Géhin, about 1850, had been popularized by the brilliant genius of M. Coste, under whose direction was established the first governmental fish cultural establishment, that at Huningue in Alsace, now the official center of fish culture in the German Empire.

The publications and experiments of Garlick, Fry, Atwood, Lyman, Green, Stone, Ainsworth, Roosevelt, Atkins, Slack, and others, awakened everywhere a sense of the fact that our rivers and streams were being rapidly cleared out, and the feeling that a similar state of affairs was probably existing in the adjoining ocean. Measures were set on foot for restoration and protection as early as 1865, when Massachusetts appointed the first commission, and prior to 1870 this example was followed by several other States. Nearly all the States and Territories now have similar organizations. In the accompanying table, prepared by Mr. C. W. Smiley, are shown the dates of organization of the several State commissions, together with the appropriations up to 1882:

* Trans. Amer. Fish Cultural Association. 1883.

Appropriations for the work of the State Fish Commissions, arranged in the order of their organization.

No.	State.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	Total.
1	Massachusetts	—	$7,000	$10,000	$12,500	$2,500	$4,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$95,500
2	Vermont	—	—	106	100	231	680	321	415	531	1,335	775	761	545	1,000	1,000	1,000	1,000	1,000	10,800
3	Connecticut		—	—	4,000	4,000	3,000	3,000	3,000	5,000	5,000	5,000	1,528	1,800	1,000	3,000	2,500	5,000	5,000	53,300
4	New Hampshire		100	1,000	2,071	1,429	1,231	1,364	1,300	2,443	1,950	1,990	776	1,528	3,204	2,077	2,000	2,000		26,463
5	Pennsylvania		—	—	—	—	—	—	—	18,080	18,080	5,470	15,000	8,000	10,000	15,000	10,000	7,500	7,500	114,630
6	Maine			1,000	1,000	3,000	2,000	2,000	2,500	3,500	4,500	1,500	2,500	3,700	3,700	—	6,075	5,000	5,000	46,975
7	New York				1,000	10,000	10,000	15,000	15,000	15,000	10,000	29,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	210,000
8	Rhode Island				—	—	1,000	2,500	1,500	1,500	1,500	1,000	500	—	—	—	1,000	1,000		11,500
9	California						2,500	2,500	2,000	2,500	2,500	5,000	5,000	5,000	4,000	5,000	5,000	5,000	5,000	52,000
10	New Jersey						—	—	1,500	1,500	2,000	3,000	2,500	5,000	4,000	5,000	5,000	4,000		33,500
11	Alabama							—	—	—	—	—	—	—	—	—	—	—	—	
12	Utah							—	—	—	—	—	—	—	—	—	—	—	850	850
13	Michigan									7,500	7,500	7,000	7,000	7,000	7,000	5,000	5,000	8,000	7,500	68,500
14	Ohio									500	500	5,000	5,000	4,000	5,000	—	9,000	5,000	5,000	39,000
15	Wisconsin									500	360	2,000	10,000	8,000	8,000	8,000	2,000	7,000	7,000	52,860
16	Iowa										1,500	1,500	4,375	5,575	4,200	4,200	3,700	3,700	3,700	32,450
17	Maryland										6,500	6,500	13,000	13,000	13,000	13,000	11,500	10,000	10,000	96,500
18	Minnesota										500	1,000	1,000	5,000	5,000	5,000	5,000	5,000	5,000	32,500
19	Virginia										—	2,500	2,500	2,500	2,500	4,000	2,500	2,500	2,500	21,500
20	Illinois											—	—	—	—	—	2,000	1,000	2,500	5,500
21	Arkansas												—	—	—	—	—	—	—	
22	Georgia												500	500	500	500	500	500	500	3,500
23	Kentucky												1,500	1,500	1,500	1,500	2,500	2,500	2,500	13,500
24	Colorado													200	200	1,000	1,000	6,000	3,250	11,650
25	Kansas													500	500	500	500	—	1,000	3,000
26	Missouri													500	500	3,000	3,000	3,500	3,500	14,000
27	Nevada													500	500	2,000	2,000	1,000	1,000	7,000
28	North Carolina													—	—	—	—	3,214	8,012	11,226
29	Tennessee													—	—	—	—	—	—	
30	Washington													—	—	—	—	—	—	
31	West Virginia													1,500	1,500	1,600	1,000	2,000	500	8,100
32	South Carolina														—	800	—	3,156	2,286	6,242
33	Nebraska															500	500	3,700	3,700	8,400
34	Wyoming															—	800	800	750	2,350
35	Texas															—	—	—	5,000	5,000
36	Oregon																—	—	—	
37	Arizona																	250	250	500
38	Delaware																	150	150	300
39	Indiana																	1,000	1,000	2,000
	Total		7,100	12,106	20,171	21,160	24,411	31,685	32,215	63,554	68,725	83,235	94,912	95,848	97,804	101,677	105,075	120,470	120,948	1,101,096

9. WHAT THE COMMISSION HAS DONE IN ARTIFICIAL PROPAGATION.

It has been stated that no legislative action has ever been recommended by the Commissioner of Fisheries. The statutes of the various States contain numerous laws for the protection of fish and fishermen, generally worse than useless, though there are many definitions of close time which appear to be beneficial. To enforce these laws would, however, render necessary a large force of fish wardens.

The policy of the United States Commissioner has been to carry out the idea *that it is better to expend a small amount of public money in making fish so abundant that they can be caught without restriction, and serve as cheap food for the people at large, rather than to expend a much larger amount in preventing the people from catching the few that still remain after generations of improvidence.*

The discussion of what the Fish Commissioner has done in the direction of fish culture has been reserved to the last, since it is so much the most extensive and, at present, practically valuable part of the work.

The relative extent of the three branches of the service may be indicated by the apportionment of the appropriation during the first ten years of the work. From $5,000 to $7,500 was annually given for the investigation into the causes of the decrease of the fisheries; for the collection of statistics nothing was specifically allotted, while the entire remainder was assigned to the stocking of inland waters. Of late years no specific allotment of the appropriation has been made, though of course the sum given for the support of the steamers is in large part to be accredited to the department of coast investigation. An examination of the accounts from 1871 to 1883 shows that from 75 to 85 per cent of the money granted has been used for propagation, and that fully one-third of the appropriations has been invested in the form of permanent appliances for present and future work.

I am indebted to Mr. Earll for the following statistics of the work of the United States Commission:

"As the operations of the Commission have increased, and the propagation of additional species has been undertaken, it has been found desirable to increase the number of hatching stations. These are of two kinds, known as collecting and distributing stations. The former are located near the spawning grounds of those species for which they are especially intended. The eggs are secured at these stations, and enough having been reserved to stock the waters of that region, the remainder are sent to distributing stations, usually located at some central point, to be hatched and shipped to the waters for which they are intended.

"The following is a list of the hatching stations operated by the United States Fish Commission in 1883:

1. Grand Lake Stream, Maine, station for collecting eggs of the Schoodic salmon (*Salmo salar* var. *sebago*).

2. Bucksport, Me., station for collecting and hatching eggs of the Atlantic salmon (*Salmo salar*), and for hatching eggs of whitefish (*Coregonus clupeiformis*) to be distributed in the waters of the State.
3. Wood's Holl, Mass. Permanent coast-station, which serves as a base of operations for the scientific investigations of the Commission and as a hatching station for eggs of the cod (*Gadus morrhua*) and other sea-fishes.
4. Cold Spring Harbor, Long Island, New York. Station for hatching eggs of various species of salmonidæ for distribution in New York and vicinity.
5. Havre de Grace, Md. Station located on Battery Island, in the Susquehanna River, for the purpose of collecting and hatching eggs of the shad (*Clupea sapidissima*).
6. Washington, D. C.
   a. National carp ponds. Ponds for the propagation of the three varieties of the carp (*Cyprinus carpio*), and the goldfish (*Carassius auratus*), the golden ide (*Idus melanotus* var. *auratus*), and the tench (*Tinca vulgaris*).
   b. Arsenal ponds. Ponds for the propagation of carp (*Cyprinus carpio*).
   c. Navy-yard. Station for collecting and hatching eggs of the shad (*Clupea sapidissima*).
   d. Central hatching station. A station fully equipped for scientific experiments connected with the propagation of fishes. The station is also provided with apparatus for hatching the eggs of all of the more important species, including light, heavy, and adhesive eggs. It is the principal distributing station of theFish Commission for both eggs and young fish to all portionsof the United States.
7. Wytheville, Va. A station for hatching eggs of brook trout (*Salvelinus fontinalis*) and California trout (*Salmo irideus*).
8. Saint Jerome's Creek, Point Lookout, Md. A station for the artificial propagation of the oyster (*Ostrea virginiana*), the Spanish mackerel (*Scomberomorus maculatus*), and the banded porgy (*Chætodipterus faber*).
9. Avoca, N. C. A station on Albemarle Sound, at the junction of Roanoke and Chowan Rivers, for collecting, hatching, and distributing eggs of the shad (*Clupea sapidissima*), alewife (*Clupea vernalis* and *æstivalis*), and striped bass (*Roccus striatus*).
10. Northville, Mich. A hatching station for the development and distribution of eggs of the whitefish (*Coregonus clupeiformis*). This station is also provided with tanks and ponds for the spawning, hatching, and rearing of brook trout (*Salvelinus fontinalis*) and California trout (*Salmo irideus*).
11. Alpena, Mich. A station for the collection and development of the eggs of the whitefish (*Coregonus clupeiformis*).

12. Baird, Shasta Co., California.
    a. Salmon station. A station on the McCloud River for the development and distribution of eggs of the California salmon (*Oncorhynchus chouicha*).
    b. Trout ponds. A station near Baird, for collecting, developing, and distributing eggs of the California trout (*Salmo irideus.*)
13. Clackamas River, Oregon. A station on Columbia River for collecting and hatching eggs of the California salmon (*Oncorhynchus chouicha*).

"The following is a list of the principal species artificially hatched in the United States, with the date when, and the person by whom, the experiments were made:

1. Brook trout, *Salvelinus fontinalis*, by Dr. T. Garlick in 1853.
2. Whitefish, *Coregonus clupeiformis*, by Müller and Brown in 1857.
3. Lake trout, *Salvelinus namaycush*, by Müller and Brown in 1857.
4. Pike perch, *Stizostedium americanum*, by Müller and Brown in 1857.
5. Atlantic salmon, *Salmo salar*, by J. B. Johnston in 1864.
6. Shad, *Clupea sapidissima*, by Seth Green in 1867.
7. Land-locked salmon, *Salmo salar*, var. *sebago*, Robinson and Hoyt in 1867.
8. California salmon, *Oncorhynchus chouicha*, Livingston Stone in 1872.
9. Striped bass, *Roccus striatus*, M. G. Holton in 1873.
10. Oquassa trout, *Salvelinus oquassa*, by C. G. Atkins in 1874.
11. Sea bass, *Serranus atrarius*, by Fred Mather in 1874.
12. Grayling, *Thymallus tricolor*, by Fred Mather in 1875.
13. Sturgeon, *Acipenser sturio*, by Seth Green in 1875.
14. Smelt, *Osmerus mordax*, by James Ricardo in 1876.
15. Herring, *Clupea harengus*, by Vinal N. Edwards in 1877.
16. Alewife, *Clupea vernalis*, by T. B. Ferguson in 1877.
17. Oyster, *Ostrea virginiana*, by W. K. Brooks in 1877.
18. Cod, *Gadus morrhua*, by James W. Milner in 1878.
19. Haddock, *Melanogrammus æglefinus*, by R. Edward Earll in 1879.
20. Carp, *Cyprinus carpio*, by Rudolph Hessel in 1879.
21. Spanish mackerel, *Scomberomorus maculatus*, R. Edward Earll in 1880.
22. Cero, *Scomberomorus regalis*, by R. Edward Earll in 1880.
23. Moon-fish, *Chætodipterus faber*, by R. Edward Earll in 1880.
24. Silver gar, *Belone longirostris*, by Marshall McDonald in 1881.
25. Gold-fish, *Carassius auratus*, by Rudolph Hessel in 1881.
26. Tench, *Tinca vulgaris*, by Rudolph Hessel in 1881.
29. Soft-shelled clam, *Mya arenaria*, by J. A. Ryder, 1881."

10. PUBLIC VERSUS PRIVATE FISH CULTURE.

In the discussion of fish-cultural economy, the distinction between PRIVATE FISH CULTURE and PUBLIC FISH CULTURE must be carefully observed, and it must also be borne in mind that the art of fish culture (*pisciculture*, *fischzucht*) as it is at present cultivated is not limited to

those animals which are grouped by zoologists in the class *Pisces*. "Fishery" is now understood to signify the exploitation of all products of sea, lake, and river; the capture of whales, turtles, pearls, corals, and sponges, as well as of salmon, mackerel, and sardines. The purpose of fish culture, or *aquiculture*, as it is in France more appropriately named, is to counteract by reparative, and also by preventive measures, the destructive effects of fishery.

By *public fish culture*, or *modern fish culture*, I mean fish culture carried on at public expense and for the public good. Public fish culture, to be efficient, must be conducted by men trained in scientific methods of thought and work.

The distinction between private and public fish culture must be carefully observed. The maintenance of ponds for carp, trout, and other domesticated species, is an industry to be classed with poultry raising and bee keeping, and its interest to the political economist is but slight.

The proper function of public fish culture is the stocking of the public waters with fish in which no individual can claim the right of property.

The comparative insignificance of the private fish culture of Europe is perhaps what has led to the recent savage attack upon fish culture in general by Professor Malmgren, of the University of Helsingfors, in Finland, which has caused so much consternation among continental fish-breeders. European fish culturists have always operated only with small numbers of eggs. The establishment of Sir James Maitland, at Howieton, near Stirling, Scotland, is the finest and largest private establishment in the world, and yields a handsome addition to the revenues of its proprietor. A description of this hatchery is published as one of the conference papers of the International Fisheries Exhibition, and that the distinction between public and private enterprise in fish culture may be understood, it should be compared with the following statement by Mr. Livingston Stone, the superintendent of one of the seventeen hatcheries supported by the United States Fish Commission, that on the McCloud River, in California:

"In the eleven years since the salmon-breeding station has been in operation 67,000,000 eggs have been taken, most of which have been distributed in the various States of the Union. Several million, however, have been sent to foreign countries, including Germany, France, Great Britain, Denmark, Russia, Belgium, Holland, Canada, New Zealand, Australia, and the Sandwich Islands.

"About 15,000,000 have been hatched at the station, and the young fish placed in the McCloud and other tributaries of the Sacramento River. So great have been the benefits of this restocking of the Sacramento that the statistics of the salmon fisheries on the Sacramento show that the annual salmon catch of the river has increased 5,000,000 pounds each year during the last few years."

In the two Government hatcheries at Alpena and Northville, Mich., there have, in the winter of 1883-'84, been produced over 100,000,000 eggs of the whitefish, *Coregonus clupeiformis*, and the total number of young fish to be placed in the Great Lakes this year by these and the various State hatcheries will exceed 225,000,000. The fishermen of the Great Lakes admit that but for public fish culture half of them would be obliged to abandon their calling.

Instances of great improvement might be cited in connection with nearly every shad river in the United States. In the Potomac alone the annual yield has been brought up by the operations of the Fish Commission from 668,000 pounds, in 1877, to an average of more than 1,600,000 in recent years.

In 1882 carp bred in the Fish Commission ponds in Washington were distributed in lots of 20 to 10,000 applicants in every State and Territory, at an everage distance of more than 900 miles, the total mileage of the shipments being about 9,000,000 miles, and the actual distance traversed by the transportation cars 34,000 miles.

Public fish-culture is only useful when conducted upon a gigantic scale; its statistical tables must be footed up in hundreds of millions. To count young fish by the thousands is the task of the private propagator. The use of steamships and steam machinery, the construction of refrigerating transportation cars, and the maintenance of permanent hatching stations, seventeen in number, in different parts of the continent, are forms of activity only attainable by Government aid.

Equally unattainable by private effort would be the enormous experiments in transplanting and acclimatizing fish in new waters; California salmon in the rivers of the east; landlocked salmon and smelt in the lakes of the interior; such as the planting of shad in California and the Mississippi Valley; and German carp in thirty thousand separate bodies of water, distributed through all the States and Territories in the Union; the two last-named experiments, carried out within a period of three years, have met with successes beyond doubt, and of the greatest importance to the country; the others have been more or less successful, though their results are not yet fully realized.

It has been demonstrated, however, beyond possibility of challenge, that the great river fisheries of the United States, which produced in 1880, 48,000,000 pounds of alewives, 18,000,000 pounds of shad, 52,000,000 pounds of salmon, besides bass, sturgeon, and smelt, and worth "at first hands" between \$4,000,000 and \$6,000,000, are entirely under the control of the fish culturist to sustain or destroy, and are capable of immense extension.

There still exists in Europe some skepticism as to the beneficial results of fish culture. Such doubts do not exist on our own side of the Atlantic, if the continuance from year to year of grants of public money may be considered to be a test of public confidence.

11. THE AIMS AND LIMITATIONS OF MODERN FISH CULTURE.

Having now attempted to define the field of modern fish culture, and to show what it has already accomplished, it remains to be said what appear to be its legitimate aims and limitations.

The aims of modern fish culture, as I understand them, are:

1. To arrive at a thorough knowledge of the life history from beginning to end of every species of economic value, the histories of the animals and plants upon which they feed or upon which their food is nourished, the histories of their enemies and friends, and the friends and foes of their enemies and friends, as well as the currents, temperatures, and other physical phenomena of the waters in relation to migration, reproduction, and growth.

2. To apply this knowledge in such a practical manner that every form of fish shall be at least as thoroughly under control as are now the salmon, the shad, the alewife, the carp, and the whitefish.

Its limitations are precisely those of scientific agriculture, and animal rearing, since, although certain physical conditions may constantly intervene to thwart man's efforts in any given direction, it is quite within the bounds of reasonable expectation to be able to understand what these are, and how their effects are produced.

An important consideration concerning the limitations of fish culture must always be kept in mind in weighing the arguments for and against its success. It is simply *this : That effort toward the acclimation of fishes in new waters is not fish culture, but is simply one of the necessary experiments upon which fish culture may be based.* The introduction of carp from Germany was not fish culture, it was an experiment; the experiment has succeeded, and fish culture is now one of its results. The introduction of California salmon to the Atlantic slope was an experiment. It has not succeeded. Its failure has nothing to do with the success of fish culture. If any one wants to see successful fish culture in connection with this fish let him go to the Sacramento River. The introduction of shad to the Pacific coast was an experiment. It succeeded. Shad culture can now be carried on without fear of failure by the fish commission of the Pacific States.

Shad culture is an established success; so is whitefish culture in the Great Lakes. The experiments with cod and Spanish mackerel were not fish culture, though there is reason to hope that they may yet lead up to it.

12. PUBLIC OR MODERN FISH CULTURE TYPIFIED IN THE WORK OF THE UNITED STATES FISH COMMISSION.

Public fish culture, then. scarcely exists except in America, though in Europe many eminent men of science appreciate its importance and are striving to educate the people up to the point of supporting it.

This doubtless seems like a very sweeping statement, and since I do not like to appear in the attitude of one who boasts of American supremacy and is not able to substantiate his position I shall endeavor to support my position by evidence.

Let us take first the prize list of the *Internationale Fischerei-Ausstellung* in Berlin.

Here is a tabulation of the prizes in fish culture:

	Gold medal.	Silver medal.	Bronze medal.	Honorable mention.
United States	6	1	1	2
Germany	3	1	3	11
Russia	1	1	1	1
Norway	....	1	....	1
Sweden	....	1	....	....
Austria	....	....	1	....
Switzerland	....	....	1	....

Here also is a tabulation of the general prize list at the International Fisheries Exhibition, London, 1883:

INTERNATIONAL FISHERIES EXHIBITION, LONDON, 1883.

Jury awards to foreign and colonial countries.

No.	Countries.	Gold medals.	Silver medals.	Bronze medals.	Diplomas.	Total.
1	United States	50	47	30	24	151
2	Norway	29	70	40	7	146
3	Sweden	27	36	40	19	122
4	Canada	17	15	6	4	42
5	New South Wales	11	9	4	1	25
6	Newfoundland	10	9	4	3	26
7	Spain	9	17	13	3	42
8	Netherlands	8	11	6	5	30
9	Russia	7	21	19	6	53
10	India	4	5	4	2	15
11	Italy	4	3	2	....	9
12	France	3	6	8	3	20
13	Denmark	3	2	9	2	16
14	China	2	3	....	1	6
15	Tasmania	1	4	....	....	5
16	Greece	1	3	....	....	4
17	Bahamas	1	1	1	1	4
18	Chili	....	2	2	....	4
19	Germany	....	1		1	5
20	Belgium	....	1	3	1	5
21	Jamaica	....	1	2	5	8
22	Straits settlements	....	1	2	....	3
23	Austria-Hungary	....	1	....	....	1
24	Tunis	....	1	....	....	1
25	Ceylon	....	1	....	....	1
26	Japan	....	....	2	1	3
	Total	187	271	200	89	747

In a dispatch to the Secretary of State, dated May 19, the American minister, Mr. James Russell Lowell, wrote:

"I have the honor to report that the International Fisheries Exhibition promises to be far more successful than even the most sanguine of its projectors had ventured to hope. The wisdom of Congress in making so liberal an appropriation in furtherance of its object is entirely

justified both by the substantial encouragement given to the enterprise at its inception, by this proof of interest on the part of the United States, and by the fact that the section devoted to our country is more valuable than that of any other, and valuable for reasons of which we may very properly be proud.

"I have the highest authority for saying that, quite apart from any consideration of intrinsic interest or curiosity, our share in the Exhibition is superior to all others in virtue of the scientific intelligence shown in its arrangement and classification, thus rendering it more instructive than any other. This is especially gratifying because it is a triumph of a far higher kind than could be won by any ingenuity in our contrivances for the breeding or mechanical perfection in our implements for the taking of fish, though in these also we may safely challenge and in some cases defy comparison.

"I shall naturally have occasion to write again and more fully on this topic when more perfectly informed, but could not deny myself the pleasure of reporting to you the impression already made in this international competition by the genius for organization of which our countrymen have here given proof, a faculty certainly not the lowest among those that distinguish the social and civilized man."

13. EUROPEAN OPINIONS OF AMERICAN FISH CULTURE.

Still more impressive are the expressions of opinion on the part of public officials and the press in various parts of Europe. I may add that it was my daily pleasure and pride, while in attendance upon the European fisheries exhibitions, to observe with what appreciative eagerness the collection sent over by our Government was studied by people of every class, by monarchs, statesmen, merchants, manufacturers, fishermen, and by the public generally. In order that the readers of this essay, who are, I take it for granted, equally interested in the matter, may share these pleasurable feelings, I will quote somewhat at length from what has already been printed, and to which they cannot well have access.

GREAT BRITAIN.—Kind words of approval from British authorities might be quoted almost without limit. The writer has in his possession a series of scrap-books, in which are arranged hundreds of quotations from English papers upon the course of the Fish Commission as illustrated at the late Fisheries Exhibition. I will only refer to the testimony of a very few. Prof. Cossar Ewart, of the Edinburgh University, in the preliminary report of the investigation committee of the fishery board of Scotland, says:

"The example set by America, Germany, and other continental states, we must follow. We have as a nation at last made a liberal acknowledgment of our ignorance, and at the conferences of the International Fisheries Exhibition expressed regret."

At the close of the late Exhibition His Royal Highness the Duke of Edinburgh, remarked: "The example of the United States is well worthy of imitation by the European nations which have large stakes in the fisheries;" and H. R. H. the Prince of Wales stated that "he was pleased to admit that in very many things pertaining to the fisheries England was far behind the United States."

"If there be," wrote, in 1879, Sir Rose Price, author of The Two Americas, "any race of people who exhibit more shrewdness than others in their ability to grasp and manipulate the apparently indistinct elements of what may lead to a commercial success, or be of ultimate benefit to their nation, those people are the Americans. No Government throws away less money in useless expenditures, and no representative assembly more narrowly criticises waste, yet the Americans subsidize considerable sums of their national revenue for the purpose of restocking the rivers of the Eastern States by artificial culture, and with praiseworthy considerations their Government supports several ably conducted establishments from which fish ova are distributed gratis to all those who choose to apply. The very railroads assist this enterprise, and some by moderating their tariff, and others by generously conveying the ova free of charge, give every possible encouragement to what their common sense tells them must lead to so much national good. To expect an English Government to exhibit the same amount of foresight, or to practice a similar generosity, would be to credit them with virtues which have yet to be developed. The American example, however, should not be lost sight of." *

Professor Huxley, commenting upon an address delivered at the conferences of the London exhibition by the present writer, said:

"The great moral of the United States contribution to this Exhibition, and especially of the contribution which Mr. Brown Goode had just made to the conferences, was that if this country, or any society which could be formed of sufficient extent to take up the question, was going to deal seriously with the sea fisheries, and not to let them take care of themselves as they had done for the last thousand years or so, they had a very considerable job before them; and unless they put into that organization of fisheries the energy, the ingenuity, the scientific knowledge, and the practical skill which characterized his friend Professor Baird and his assistants their efforts were not likely to come to very much good. One of his great reasons for desiring that the subject which Professor Goode had put before them should be laid distinctly before the English public was to give them a notion of what was needed if the fisheries were to be dealt with satisfactorily; *for he did not think*, speaking with all respect to the efforts made by Sweden, North Germany, Holland, and so forth, *that any nation at the present time had comprehended the question of dealing with fish in so thorough, excellent, and scientific a spirit as that of the United States.*

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* The Fishing Gazette, London, III, p. 65.

The Rev. W. S. Lach-Szyrma, of Newlyn, England, in a lecture upon the late Exhibition, made the following comparison:

"At the Paris Exhibition he considered Europe as a man in full vigor, Asia as a decrepit old man, America as a boy, Australia as a baby. In the present Fishery Exhibition the case was different. * * * America was the gem of the Exhibition."

The London "Shipping World" (June, 1883) remarked: "Foremost in practical value, as in interest, is the court occupied by the United States. Not only are the fisheries of the States of great importance, but that importance is fully recognized and fostered by the Government. The United States Fish Commission was intrusted by Congress with £10,000, and the task of preparing a complete and systematic representative exhibition of the fisheries of the United States. The work has been most admirably performed. * * * *We are quite safe in saying that we have not a single Government department in this country, in any branch of industry, which, with the help of double the money, could produce anything so representative and instructive as we find here.*"

Major-General A. Pitt Rivers, one of the vice-presidents of the Anthropological Institute of Great Britain, in a letter to the London Times, expressed the following opinion as to the methods by which the fishery resources of the country were displayed, which I quote as showing how the character of the work of the Commission is regarded by such high scientific authority:

SIR: In confirmation of the praise you justly bestow on the arrangement of the United States department in the Fisheries Exhibition, I beg to draw attention to the fact that in the whole exhibition it is the only one which is arranged historically. In the Chinese, Japanese, Scandinavian, and Dutch courts there are objects which the scientific student of the arts of life may pick out and arrange in the proper order in his own mind; but in that of the United States * * * following the method adopted in the National Museum in Washington [there has been] attempted something more, to bring [the] department into harmony with modern ideas. * * * This gives to the Exhibition an interest which is apart from commerce, and an interest which is beyond the mere requirements of fish culture, and it may be regarded as one out of many indications of the way in which the enlightened Government of the United States mark their appreciation of the demands of science.

I have the honor to be, sir, yours obediently,

A. PITT RIVERS.

The Pall Mall Gazette, June 8, 1884, remarks:

"The United States section is a department whose importance grows upon the inquiring visitor at every inspection. With fisherman and angler alike it holds the supreme position in the entire Exhibition. The section forms a very flattering manifestation of international courtesy upon the part of the Government at Washington; for by far the largest part of the exhibits are from the National Museum at Washington, and from the storehouses of *the United States Fish Commission—an institution for which it would be rather difficult to find an English counterpart*—the private exhibitors, particularly trading exhibitors, being very few.

Of the comprehensiveness and completeness of this really national exhibition, it is impossible to speak too highly."

"The part of the Exhibition I like above all others," wrote the editor of "Engineering," "is the United States section. The collection of exhibits is so well chosen and completely labeled that one can always be sure of obtaining valuable information on some point or another connected with fishing at a small expenditure of trouble. It is a great relief, after wrestling in vain with the bloated, useless official catalogue in the main building, to find oneself in a compact, well-arranged department, nearly every exhibit in which bears a fully descriptive label."

The London "Field" of July 21 remarked: "It is impossible to enumerate all the objects of interest in connection with the northern whale fishery, but I would especially call attention to the beauty of the United States lay figures for exhibiting the use of the implements displayed. * * * The same care and completeness is visible in every department of the United States exhibit, and their masterly collection of reports and memoirs on the industries, products, and natural features of their country, as well as the liberality with which the results are distributed to students of other nations, speak volumes for the enlightenment and progress of a great people, as well as for the ability of those who have charge of the various scientific departments."

"The Thames," of July 13, said: "We would advise the visitor to make the United States exhibit the starting-point in his survey. He will here find an epitomized museum of angling appliances, arranged in historical developmental order. The United States exhibit is a model as to the arrangement of any economic museum."

Said the "Yorkshire Post" of June 1: "It is really hopeless, save at very great length, to give an adequate idea of the comprehensiveness of these American exhibits. The exhibition does immense credit to the United States Government. It is not only the largest but the most systematically arranged of any of the foreign contributors."

Said the "Glasgow Herald" of May 19: "A leading, if not *the* leading place must be given to the United States. * * * It is an exceedingly comprehensive collection, illustrating in the fullest manner the various branches of fish culture and capture as carried on in the United States. Each department is under the charge of a skilled person, whose duty it is to give information to visitors. These officials are always at hand, and are as ready and fluent in conveying information as if instead of coming from America, they had been nurtured in Paris, the city of politeness. It may be as well to add that what they have to communicate is marked by greater terseness and exactness of statement than could be expected in the case of a Frenchman."

Says the "Birmingham Post" (May 30, 1884): "The leading place indisputably belongs to the United States, whose participation is in accordance with an act of Congress by which the Commissioner of Fisheries was instructed to prepare a complete, systematic, and representative exhibition."

Said the London "Standard" (September 17, 1883): "There is no other country which contributed such large and well-defined collections on such an important and adequate scale as the United States. The display of these vast stores of material in an accessible form, and with scientific knowledge as well as skillfulness of arrangement for effect, does great credit to those to whom the interests of the American exhibit have been intrusted. * * * To describe the American contribution thoroughly would take more than a volume, for there is not an admissible subject that is not fully illustrated by models, drawings, books, photographs, and actual specimens."

"England" (June 30, 1883), remarked: "The United States court is certainly the most instructive in the Exhibition. It represents such a vast industry, and has been arranged in so methodical and intelligent a fashion."

Said the London "Evening News" (June 22, 1884): "It is only natural that the exhibits from the great Republic should hold a very prominent place both as regards importance and number. * * * So large indeed is the court, and so very varied and interesting, are the things there shown, that it would be quite a hopeless task to try and even give a faint description of them in one article."

NORWAY.—In a report to the Norwegian Government, after his return from a visit to the United States in 1876, Mr. F. M. Wallem, one of the principal fishery authorities of that country, wrote: "In a book on trout culture, written by a practical breeder, it is said * * * that 'it pays better to rear trout than hogs,' and every one knows what the pork business is for America. All that I have learned indicates that this assertion has gained general acceptance, both among the common people and the learned; and it is said to be admitted that *in the art of rearing fish the Americans surpass all others.* Partly to control the fisheries themselves, and partly to carry on hatching operations, there were appointed in eighteen different States, taken together, fifty-two commissioners, besides a regular staff of subordinate officials. There was established by the United States Government, besides, a Fish Commission, whose chief is the well-known Prof. Spencer F. Baird. With this complement of special, practical, cultivated officials, and talented, scientific men, the effort was untiring to produce and distribute young fishes. * * * From what I have communicated it will presumably be evident that *the American example contains a stirring invitation to Norway to develop her fresh-water fisheries, which are now greatly neglected.*

THE NETHERLANDS.—I quote a few sentences from a recent essay on the London Fisheries Exhibition, by Prof. A. A. W. Hubrecht, of the University of Utrecht, one of the Dutch Commission of Fisheries.

"Whilst in Europe fish culture, if not exclusively, at any rate principally occupies itself with the *Salmonidæ*, America also raises artificially other kinds of fish, * * * fish belonging to the *Clupeidæ* and the *Cyprinidæ*, and even codfish. As regards the last-named species

this seems almost incredible. Whenever I have taken the trouble to protect a codfish, when still in the egg, and as a young fish, I found that in that condition it was worthless for us, because to make it grow as it should it must return to its own element, the sea; and there to find it again at a later period seems just as hopeless as the desire of Polycrates that the waves of the ocean should return to him his golden ring. And still, correct as this reasoning may appear, the Americans will prove the whole thing to us in dollars and cents; whilst the delighted fishermen of Gloucester would soon convince you of the contrary if you were to tell them that their increased codfisheries were simply caused by accidental circumstances and not by the energetic work of Professor Baird and the United States Fish Commission. * * * The head of the American commission to London said to me: 'In our country we would as little think of leaving fish culture to private effort as of taking from the hands of the Government the care of the light-houses.' Well said, but not very pleasant for the ears of true adherents of the Manchester school. These words should be taken to heart in Europe, and especially in the Netherlands. *It is to our immediate interest that * * * we may be the first to reap the fruits of American teaching and to take the front rank in the European fish markets, which belongs to us rather than to other countries which, owing to their location, are not able to imitate the example set by America as well as we can.*"

"Of the nine Government institutions, which are either wholly or in part intended for making investigations on the field of pure and applied science,* the United States Commission of Fish and Fisheries is at this day, to quote the words of its historian, '*the most prominent of the present efforts of the Government in aid of aggressive biological research.*' Every person in Europe who has followed its career and who has studied its reports, will cheerfully subscribe to the truth of the words quoted above, which in such terse form expresses the deep interest which the Government of the Union takes in these researches; and we must not fail to mention that the energetic American mind did not only invent this term ('aggressive research'), but that it has also understood to make the aggression in such a manner as to conquer all opposition.

"Perhaps the time is near—and would that the London Fishery Exposition might hasten it—when the eyes of our representatives will be opened to the great importance to the welfare of our country of 'aggressive research.'

"*After briefly mentioning material aids, we must not forget to refer to the intellectual aid placed at the disposal of the Commission. Under the supervision of the Commissioner there is a full staff of experienced and skillful naturalists, which works into a whole all the various observations, and orders the new investigations called for by such observations. Their ranks*

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* *Een verwaarloosd Volksbelang.* "A neglected public interest," in a reprint from "de Gids," No. 7. Utrecht, 1883.

are filled by young men who, after having completed their education at some college, desire to devote themselves to the science of zoology, more especially in a field where that science not only promises to supply many of the daily wants of the masses, but where it has already accomplished a great deal. They are the men who use for investigations in the field of embryology the exceedingly valuable scientific material furnished by the numerous stages of development of fish which may be observed in practical fish culture. We may doubtless look for important communications relative to the results of these scientific investigations.

"*Round this staff of scientists there has gradually been formed an entire corps of officers who are thoroughly versed in the more mechanical work of fish culture and fish transportation. The catching of mature fish, the impregnation of the eggs, the care of them during their development, and the raising of the young fish can only be intrusted to experienced persons, although a scientific education is not required for this work.*

"In what manner can the Netherlands derive the greatest possible benefit from the lessons taught by the American exhibit at the London Fishery Exposition? Certainly not by leaving fish culture, in the future, principally in the hands of private individuals. In this way we may get a number of establishments which may be placed on a line with establishments for raising chickens and pigeons, but the public interest is not advanced thereby. For this purpose it is absolutely necessary, as has been mentioned above, that the Government take the matter in hand and follow out a carefully prepared programme."

GERMANY.—The verdict of Germany bears no double interpretation when we examine the trophy awarded to our Commissioner of Fisheries at the Exhibition of 1880, and remember the words of Herr von Behr, the president of the Deutscher Fischerei Verein, that it was given to him as "the first fish culturist in the world."

It will do no harm, however, to quote also from the report of Director Haack, the head of the imperial hatching establishment at Hüningen, the paragraph relating to the American section at Berlin.

"Everything which America had sent was on a magnificent scale. We shall therefore only * * * admit the truly superb scientific collection, filling several rooms, and finally devote some time to the department of pisciculture. Much of the apparatus was already known to us, as for about three years we have imitated the Americans in this respect. * * * Lost in astonishment, we stand before the large model of the Fish Hawk, a large steamship specially constructed by the American Government for purposes of pisciculture. * * * With all our piscicultural efforts we must confess that we felt very small when viewing this grand American exhibit, and the magnificent results obtained in America are a sufficient guarantee that this is no 'American humbug.' For the present we can certainly do no better than to strain every nerve and imitate the example set us by the Americans."

The juries of the Fishery Exhibition of Berlin in their official report remark:

"*We must thank America for the progress which fish culture has made during the past decade*, and the new inventions through which this progress has been accomplished were very fully shown at the Exhibition. The American section was therefore in the highest degree instructive and interesting to every practical fish-culturist."

BELGIUM.—The Hon. E. Willequet, in a speech before the Belgian Chamber of Deputies recently, remarked:

"Heretofore there has been no thought except regarding the fishery in our rivers and their tributary streams. There is another fishery * * * which is carried on in the lowest parts of our rivers, in the Escaut and in the Meurs. Now, this is a source of wealth which is most completely slighted and yet is exceedingly valuable. I could attest by statements emanating from the highest authorities that with a slight expense these water-courses could be peopled at will with excellent fishes. In America this is done every day, *The great Commission of Fisheries established by the United States Government has led to positive results which can be verified at any time.*"

FRANCE.—M. C. Raveret-Wattel, the principal French authority on pisciculture, in a recent essay writes:

"*To this day pisciculture has nowhere produced results which can be compared with those obtained in the United States.* In no other country has this industry attained to the same degree of development, perfection, and success. But it must also be said that perhaps no other nation has so fully understood the great importance of pisciculture and that in no other country have such great efforts been made. *Nowhere, certainly, has so much been accomplished by private enterprise; nowhere has the Government given so much enlightened care to the rational cultivation of the waters, and afforded such efficient protection and generous encouragement.*"*

SPAIN.—Capt. Andres A. Comerma, of the Spanish navy, commenting on the methods of fishing and fish culture as shown at the London Exhibition, wrote:

"It would be necessary to write a voluminous work were I to attempt to discuss in detail the exhibition of these methods, which are unequaled elsewhere in the world, and which show how *this young and vigorous nation, the United States, is pressing forward in competition with Europe, surpassing in many things even England, Germany, and France, who together formed the vanguard of progress in olden days.*"

ITALY.—In the official report of the Italian commission to the Berlin Exhibition it is remarked:

"The juries very justly awarded the first prize of honor to Prof. Spencer Baird, Secretary of the Smithsonian Institution and head of the United States Fish Commission, a man of most indefatigable energy,

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* Bulletin mensuel de la Société nationale d'acclimatation de France, 3, IX, 1882, p. 69.

who, although absorbed in important public duties, has found time to devote a part of his life to science."

14. THE CAUSES OF THE SUCCESS OF THE UNITED STATES FISH COMMISSION.

To what elements of strength does the United States Fish Commission owe its long-continued success? It may seem a waste of paper to try to answer this question, but at the risk of seeming verbose I venture to make the attempt.

(1) *The work of the United States Fish Commission owes its value solely and entirely to the fact of its being based upon an extensive and long-continued system of scientific investigations*, for the purpose of discovering unknown facts, the knowledge of which is essential to the welfare of the fisheries, the economical management of the national fishing resources, the success of fish culture, and the intelligent framing of fishery laws.

The resolution establishing the Commission requires that its head shall be a civil officer of the Government, whose services shall be at the command of the President, and who possesses proved scientific and practical acquaintance with the fishes of the coast, thus formally fixing its scientific character.

The work of the Commission is and has always been under the direction of eminent and representative scientific specialists acting as heads of its several divisions, and the employés, with the exception of a very limited number of clerks, are trained experts, usually scientific students—so exact and special is the training required even for subordinate positions, that in a majority of cases each man employed is the only man in the country who understands and can perform his own individual work.

The character of the scientific work has been determined from the start by the intimacy of its affiliation with the Smithsonian Institution, famous throughout the world as a nursery of scientific enterprises. No organization in the United States not so affiliated, could by any ordinary means have secured the co-operation of so many master-workers, whose aid has been so important to the success of its plans.

(2) *The successful application of scientific methods of work has always depended upon the entire freedom of the service from departmental routine.**

* Since the preparation of this paper has been begun the writer has been informed that there is a feeling in some official circles in favor of the subordination of the Fish Commission to some one of the Executive Departments of the Government.

The chief argument in favor of such a change is said to be based upon the idea that every branch of governmental work should be in some way under the surveillance of a Cabinet officer. Without attempting to antagonize this view, I shall attempt to show that this policy is by no means a general one, and that the Fish Commission is one of the branches of the service which would lose more by such transfer than it could possibly gain.

In the first place, let us review the status of the offices of the Government which are not subordinated to any Executive Department.

Chief among them is the Agricultural Department. This is simply a bureau or

Much of the work is now done by volunteers, in addition to duties elsewhere in colleges, scientific institutions, and other departments of government, and in their own time. This is especially true of the heads of scientific departments, whose services money alone would not secure, and not less so of many of the best younger workers, who serve the Commission at extremely low rates of pay for the sake of the advantages they have for preparing themselves to hold scientific positions elsewhere. No regular force outside of the staff is kept up throughout the year, and at certain seasons four times as many men are employed as at others. With the departmental system of regular appointments and graded salaries the cost would probably be twice as great as it now is.

Furthermore, the system of appointments necessarily in vogue in an executive department, with the periodical changes of assignment, which are customary in some of them, would prevent the greatest efficiency in work. We are accustomed to consider the English civil service to be one of the best in the world, to praise its efficiency, and to hold it up for emulation. Efficient it may be in departments where routine work is the chief occupation of the officials, but it sometimes falls short in the matter of organizations requiring special qualifications in

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commission corresponding in every essential respect to the United States Fish Commission. It is proposed to make it a cabinet office, but this has not been done. Other offices of a similar character are the National Board of Health, the Civil Service Commission, the United States Tariff Commission, the United States Fish Commission, the Government Printing Office, the Library of Congress, the District Government, Congress itself, the Smithsonian Institution, National Academy of Sciences, &c. All these bodies are distinct and separate in their organization and responsible in part to the President and in part to Congress, but they are not related in any way to a Cabinet officer. The United States Fish Commission exactly corresponds to its title, and *is* a commission to do certain things ordered by Congress. The Commissioner is appointed by the President, and makes his report directly to Congress, and may be in a certain way considered a Congressional official. There is a Senate Committee on Fish and Fisheries which is related to the United States Fish Commission, and I presume in time there will be a committee of the same character in the House having direct relationship to it. The Civil Service Commission is related in a similar manner directly to the President, and very properly is not placed in immediate connection with any Department, as it regulates and controls them all.

The Fish Commission, as has been stated, is authorized by Congress to call upon any Department for aid in its work, which has always been readily and promptly granted. To place it under one Department rather than another would be to confine its relationships entirely to that Department, as the others would no longer render the same ready assistance.

If the Fish Commission is to be subordinated to any Department, it should be by all means to the Smithsonian Institution, which is the only branch of the Government to which it is akin in purpose and method. That it is scientific and not executive in its methods has already been shown. Departmental subordination always dampens the enthusiasm and stifles the energy of scientific workers, though many Department officers in their individual capacities do excellent work. Especially unfortunate would be subordination to a division of the Government whose interests, so far as science is involved, are naturally and necessarily in lines quite at variance with the biological investigation for which the Fish Commission was organized.

their membership. Let me quote a few words from "Fairplay," a London journal of considerable prominence. After discussing the make-up of our Fish Commission somewhat at length, the editor, speaking of the head of one of the divisions, continues: "Such is the man our practical cousins across the Atlantic have put on a public commission, his sole recommendation being that he is thoroughly fitted for the post. In England we should have given the post to a Government clerk, or ex-private secretary who had established a claim upon some minister, a troublesome M. P., or perhaps a "younger son." Whether all or either of these had the remotest knowledge of fishery matters would be probably the last consideration that would have been considered a recommendation for the post." ("Fairplay," October 5, 1883, p. 490.)

The usefulness of the Commission depends in great measure upon the rapid dissemination of knowledge concerning fish, fisheries, and fish culture, through its reports and bulletins. Delay would undoubtedly result from subordination to an executive department, and supervision by a purely executive head would cramp the movements and dampen the enthusiasm of the contributors to these serials, and reduce them to the uninteresting level of the ordinary executive report, such, for instance, as that of the Canadian Fishery Commission, which consists chiefly of financial statements and files of official correspondence.*

The methods of a scientific commission cannot be replaced by those

*Although the publications of the Fish Commission are undoubtedly highly appreciated, it seems to me doubtful whether their importance to science and to technology is thoroughly understood. I would advise those interested to examine carefully the classified list of Fish Commission papers recently published by Mr. Smiley in the Bulletin of the Fish Commission, for 1883, pp. 1–84. From this list it appears that as a result of ten years' work 968 separate contributions have been printed.

Having quoted the opinions of European authorities upon the other branches of the Fish Commission work, I cannot refrain from repeating here what has been said about one of its recent publications by "Nature," the leading scientific weekly of England.

"UNITED STATES COMMISSION OF FISH AND FISHERIES.

"Part vii. Report of the Commissioner for 1879.

"The contents of the present volume, embracing details of the work done by the United States Fishery Commissioner for the year 1879, are quite as varied and even of greater interest, if that be possible, than the preceding reports. The specific objects of the methodical inquiry which has now been going on for over twelve years has for its object to report progress in regard to the propagation of food-fishes in the waters of the United States, as also to afford information as to the decrease in stock of food-fishes. As has been already stated in the columns of Nature, in which previous reports have been reviewed, the inquiry which has been so long in progress is being conducted in a thorough and searching way; it embraces the consideration of every topic calculated to throw light on the economy of the American fisheries. Nothing that can be deemed illustrative is neglected—the literature devoted to the natural history of food-fishes, or to descriptions of the fisheries of other countries, especially those of Europe, has been largely utilized in preparing the reports, with the result of making the volumes which have been issued a perfect encyclopædia of fishery information. Among the distinctive articles contributed to the present volume are some of rare importance; we may refer to that by Professor Farlow on 'The Marine Algæ of New England,' which is both interesting and exhaustive; it extends to 210 pages of the volume now before us, and is illustrated by a series of well-

of one of the bureaus of an executive department. Except in the divisions of records and accounts routine is reduced to a minimum; and, indeed, the amount of clerical work is very small. Any kind of departmental routine would be prejudicial to the service, particularly of that kind which would trammel the action of its presiding officer.

In support of this statement, let us examine the condition of affairs in England. The fishery interests of the nation, so far as inland waters are concerned are assigned to the home office, and Her Majesty's inspector of salmon fisheries occupies a desk in one of the imposing departmental structures at Whitehall. Following the example of the United States an eminent zoologist, the president of the Royal Society, Professor Huxley, occupies this position, which corresponds, in England, more nearly than anything else, to our Commissionership of Fisheries. Bound hand and foot by departmental routine, Professor Huxley, whom no one can accuse of lack of originality in conception and enterprise in execution, has, during his three years of office, done nothing in any wise different from what was done by his predecessor, who was not a man of science—nor could he if he were to try.

Holland, Germany, and Norway, are the only European nations which exhibit intelligent enterprise in the consideration of fishery questions in general, although fair work is done by Sweden and other countries in the treatment of limited special branches of this industry. These three countries are, it should be noted, the ones in which special commissions, independent, in a measure, of administrative control, have been organized.

In Germany, which leads the van, the functions of the German Fishery Union (*Deutscher Fischerei Verein*), and of the commission for the in-

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executed drawings. Another paper of importance, full of curious information, is that of Mr. A. E. Verrill, 'On the Cephalopods of the Northeast Coast of America;' it is also profusely illustrated with fine drawings. 'The Propagation of the Eel' is a contribution which is sure to attract attention; the article is by Dr. Otto Hermes, and was read before the German Fishery Association. Although brief it contains many features of interest in connection with the natural history of the curious animal of which it treats, and describes most distinctly the differences of the two sexes. The author of this paper announces that the old eels, both males and females, die soon after the spawning season; 'the extraordinary rapid development of their organs of generation exhausts them to such a degree that they die soon after having spawned.' This is the reason why they are never seen to return to the rivers. Among the miscellaneous contents of the present report will be found instructive essays on the food of marine animals, by Prof. K. Möbius. In the appendix will be found a very readable account of the herring fisheries of Iceland, as also a short treatise on the fisheries of the west coast of South America. One of the most important scientific papers which is given is one containing a reprint of a series of extracts from the investigations of the Commission for the Scientific Examination of the German Seas; it contains much that will prove of interest both to naturalists and economists. *It may be safely said alike of the present and the preceding reports, that they contain a mass of information on fish and fisheries of a kind which has never been before brought to a focus, and in issuing such a guide to all interested the United States Government has set us an example which we ought at once to follow.* The volume is published at Washington, and is printed at the Government Printing Office."

vestigation of the German seas (*Ministerial-Kommission zur wissenschaftlichen Untersuchung der deutschen Meere zu Kiel*), taken together represent practically the two divisions of the work of the United States Fish Commission, namely: "Propagation and investigation."

The latter body is composed of a commission of scientific men, whose head is appointed by the Government; is carried on with Government funds, but is not in any way subjected to Government control, the central headquarters being at Kiel instead of Berlin.

The Fischerei Verein is a private body, under the patronage of the Emperor, and with funds partly furnished by the Government, and having also the general direction of the National Fish Cultural Society at Huningue. This, also, is not a bureau of any Government department, but managed entirely by its own officers. It is the only European fisheries established that has so far constituted a thoroughly successful experiment.

The Netherlands Commission of Sea Fisheries (*Collegie voor de Zeevisscherijen*) is a body of fifteen men, chiefly workers in science, occupying a responsible position in the national economy, their function being "to advise Government in all subjects connected with the interest of the fisheries." During the twenty-five years of its existence, says its historian, "the commission has constantly been consulted by Government on the different measures that might be beneficial, or on the abolition of others that were detrimental, to the fisheries."

The Society for the Development of Norwegian Fisheries (*Selskabet for de Norske Fiskeriers Fremme*) is an organization independent of the Government, and electing its own officers, but receiving large grants from Government to carry on work precisely similar to that of our own Commission. In 1882-'83 these grants amounted to 49,000 kroner.

(3.) *Co-operation with organizations and individuals outside of the organization itself has been carried on to the very great advantage of this work*, and has enabled the Commissioner to accomplish very much more than would otherwise have been practicable with the means at his disposal.

This policy, which has been carried out by the Fish Commission to a very much greater extent than by any other governmental organization save the Smithsonian Institution, is an extension of the time-honored policy of the Smithsonian Institution, and applied by means of experience gained in its service by those who have been employed interchangeably in the two establishments.

This co-operation is varied in character. In some instances it is reciprocal, being carried on with persons who are interested in accomplishing the same end, and who share in the benefits of its accomplishment. Of this character has been the affiliation of the Commission to scientific institutions and individual investigators, who, as has already been stated, are willing to aid in the work for the sake of the opportunities for study and publications which they receive. Of this character

also has been the relation of the Commission to the National Museum, both establishments being equally concerned in the acquisition of material illustrating the natural history of our waters and the methods of the fisheries; the former for purposes of immediate study, the latter for permanent preservation and exhibition.

Of this nature, too, has been the relation of the Commission to similar organizations abroad, resulting in the interchange of publications and experience, and the exchange of native species of fishes for experiments in acclimatization and fishery apparatus for introduction. Co-operation of this kind has been and is sustained with every nation in Europe.

The moral influence of such international comity is not to be slighted. I am tempted in this place to quote from a speech recently delivered in the Belgian Chamber of Representatives by one of its prominent members, M. Willequet:

"On the subject of the fisheries," he remarked, "new relations have recently sprung into being between different Governments. We notice a kindness and disinterestedness and eagerness to oblige, which have not hitherto been a characteristic feature of these reciprocal relations. There are being carried on to-day between the United States, France, Switzerland, Italy, and England exchanges of fish eggs and fry which attest a cordiality most remarkable and most profitable. Not a year passes that the North Americans do not make important shipments of fish in every direction, and they not only make presents of them to other countries, but send persons to accompany each lot in order that they may arrive in the best condition."

Of this character, too, has been the relation to the Interior Department in connection with the census work upon the statistics of the fisheries, with the Department of State in connection with the conduct of international exhibitions abroad, with the Navy Department in affording training in scientific methods for young Naval Academy graduates detailed for that purpose.

In co-operation of another kind the Commission has received more than it has returned.

According to the provisions of its law of organization the Commissioner is empowered to call upon any of the Executive Departments for assistance, and very much has been done every year through the aid of the several Departments which would otherwise have been impracticable.

Important relations of this kind have in past years, and are still from time to time, kept up (1) with the Treasury Department, in connection with its Bureau of Statistics, in connection with its life-saving stations and light-houses, where temperature observations are kept for the use of the Commission, and observations made upon the movements of marine animals; also in the occasional facilities afforded by

the Secretary in connection with the use of revenue cutters and coast-survey vessels, and in the occupation for many years by the Commission of a portion of the wharf of the buoy station at Wood's Holl; (2) with the War Department, and in the military guard supplied to the hatching station on the Sacramento River, and in the supply of thermometers for the use of coast observers of the Fish Commission; (3) with the Navy Department, in the facilities afforded for the use of naval vessels in the coast work in past years; also in facilities afforded by the Navy Department in fitting out Fish Commission steamers with officers and men.

Important benefits have been derived also from the courtesy of transportation companies, by whom eggs, young fish, and other property of the Government have been carried from place to place at greatly reduced rates, the charges being in many instances entirely remitted. In the fiscal year of 1884 concessions of this kind amounted to more than $12,000.

Finally, the Commission co-operates in many enterprises in which the benefit is entirely that of the other partner. Pre-eminent in this class has been its relations to the various State commissions. By reference to the table above on page 18 it will be seen that the various State governments had appropriated for fish propagation, up to 1882, over $1,101,000, a sum considerably exceeding that appropriated by the Federal Government for the same purpose, the total amount to the middle of 1883 having been $1,190,955, of which about one-fourth must be credited to the account of the ocean fisheries inquiry and the construction of the steamer Albatross, leaving a balance of from $750,000 to $800,000 expended in fish propagation.

The success of the propagation work of the several States has for ten years past depended in a large degree upon a long-established system of co-operation between the Commissioner of Fisheries and the several State fish commissions, some thirty in number, by whom the General Commissioner is regarded as a general advisory and executive head. The United States Commission cannot operate in waters belonging to an individual State, but can supply that State with fish to be planted by its local authorities, and has already accomplished very much in this manner. Co-operation of this kind would not be easily practicable under the direction of an Executive Department whose Secretary and whose policy are frequently changing.

Relations of this kind have also been kept up with the Department of State, in connection with the conventions and other deliberations for the construction of fishery treaties, in which the staff of the Commission have served as experts, with the Treasury Department in preparing opinions upon the character of supposed dutiable articles of import, and with the War Department in connection with the erection of fish ways by the Engineer Bureau, also with the Navy Department

in the loan of the steamer Albatross for the work of the Hydrographic Office.

15. CONCLUSION.

As early as 1869 all the essential features of the work, except that of the propagation division, were put into operation by the present Commissioner, at Wood's Holl, on the southern coast of Massachusetts, at his own private expense. The following year his own resources were re-enforced by a grant of $100 from the secretary of the Smithsonian Institution. In 1871 Congress allowed him $5,000 for current expenses in an investigation of the fishery dispute then existing in Southern New England.

From this beginning has grown up the Fish Commission, an institution peculiarly American in its conception, and without a parallel in any other governmental organization.

It has achieved a world-wide reputation for its enterprise and originality of method. Its work is better appreciated abroad than in the United States, and at the International Fisheries Exhibitions at Berlin and London—at the former with eighteen sister Governments competing; at the latter with thirty-five—carried away a majority of the prizes for supremacy both in scientific method and practical results. Throughout Europe the Fish Commission is being held up as one of the most striking evidences of the public spirit, intelligence, and liberality of the American nation.

"It is a matter of peculiar gratification," remarked the Hon. Samuel S. Cox, of New York, in a recent speech in the United States House of Representatives, "that even as late as the 9th of February, 1871, Congress passed a general and generous law providing for investigations as to the diminution of our food-fishes; and that at the same time it took measures for their increase and distribution. It is also a matter of congratulation that the resolution establishing the office of Commissioner of Fish and Fisheries led the way to the selection of Professor Baird, who has not only assisted as Secretary of the Smithsonian Institution in the increase and diffusion of knowledge among men, but who has also increased and diffused both fish and the knowledge thereof among men, women, and children in forty States and Territories, not to speak of what he has done in the way of international exchange.

"That he carried off the highest of the honors at the Berlin exhibition, that our country won the highest prizes in London, and that these glories have inured to the general welfare, is not the least among the benefactions which science in its practical application has showered upon the people of this country, and which they have gladly shared with the millions of other lands. Let the good work go on! Let Congress appropriate its generous aid to the hatching stations and ponds where

science is doing this grand and useful work! Let the eulogy of Professor Huxley upon the ingenuity, energy, and scientific knowledge of Professor Baird and his assistants find a general echo in our homes, as well as here and now, to the end that something of that praise which comes after our labors are done may greet these fishers in the waters of science while they are in full hope, faith, and life to enjoy our laudations!"*

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* Congressional Record, May 12, 1884.

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[NOTE.—The references are to page-figures in brackets.]

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XLII.—THE RESULTS OF THE LONDON FISHERIES EXHIBITION IN THEIR PRACTICAL VALUE FOR GERMANY.*

BY DR. BERTHOLD BENECKE,
Professor in the University of Königsberg.

In consequence of the successful Fishery Exposition arranged four years ago in Berlin by the German Fishery Association, public interest in this subject began to be awakened also in England, which had not been well represented at the Berlin Exposition. After small exhibitions had been held in Norwich in 1881, and in Edinburgh in 1882, a most imposing International Fisheries Exhibition was, in May, 1883, opened in London by His Royal Highness the Prince of Wales. This exhibition formed the principal object of interest to visitors to London for half a year, was visited by 2,500,000 persons, produced a perfect flood of ichthyological literature, and directed the attention of the great public in the most energetic manner to the importance of the fishing industries.

Acknowledging that in the sea-fisheries, to which the London Exhibition was principally devoted, we could in no wise compete with other nations, Germany was not represented by an exhibit; but by the aid of the ministry of agriculture the German Fishery Association was enabled to send a number of reporters to London, in order to study the exhibition and examine what might be of practical value for Germany.

THE SEA-FISHERIES.—The principal point of attraction, and the subject best represented, was, of course, the great sea-fisheries, an industry yielding in the United States an annual income of 450,000,000 marks [$107,100,000], in England of 240,000,000 marks [$57,120,000], in France 80,000,000 [$19,040,000], and in Norway 25,000,000 [$5,950,000]. Unfortunately the results of our German sea-fisheries are very insignificant when compared with these figures, although a sea rich in fish—the North Sea—washes a long stretch of our coast, and although we are not much farther from the rich fishing-grounds than most other nations (and even nearer than some) which annually catch there several million marks' worth of fish.

THE BEAM-TRAWL.—The most important fishing apparatus for flat-fish and round-fish, which furnishes the greater portion of the 140,000 tons of fish annually consumed in London, is the beam-trawl, a net which

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was introduced in England only about sixty years ago, and which, though in a smaller form, has been in use on the German North Sea coast for a long time and is known by the name of "*kurre*." The trawl-net, a funnel-shaped bag, measuring 100 feet in length, and having an opening of from 30 to 50 feet, is fastened to a beam resting on runners, and being heavily weighted is dragged along the bottom of the sea by a sailing vessel or steamer. Thirty years ago Grimsby had only one trawl-net, while now it has from 600 to 700, which are taken to sea in much larger vessels than formerly, having a crew of 6 or 7 men each. In 1845 Hull had 21 fishing vessels, of 570 tons, valued at 128,500 marks [$30,583], while in 1883 there were engaged in the trawl-fisheries 417 vessels, of 29,233 tons, with 9 steamers and ice-vessels, valued at 11,000,000 marks [$2,618,000]. In all England there are at present engaged in these fisheries 3,000 sailing vessels and steamers. The capital invested in this industry is 300,000,000 marks [$71,400,000], and the annual income therefrom is upwards of 70,000,000 marks [$16,660,000]. The total crews of this vast fishing-fleet number from 15,000 to 20,000 men, and as many are employed on shore in preparing, packing, and shipping fish.

DECREASE OF THE FISHERIES.—For flat-fish and cod, at a considerable depth, up to 100 meters [55 fathoms], the trawl-net is well suited, but undoubtedly does great damage near the coast by destroying enormous masses of young flat-fish which are not yet fit for use. The trawl-fishers themselves grant that frequently as many tons of crushed young fry are thrown overboard as are caught for the market. Hundreds of thousands of hundredweights of young flat-fish are annually used as manure, and people may say what they please about the inexhaustibility of the sea, yet it is an undeniable fact that, as in the Baltic since the introduction of the "*zeese*" [a net resembling the trawl net], the size of flounders has decreased to an alarming degree, so in the North Sea the flat-fish seem to be constantly growing smaller as the number of trawl-nets increases; that many places where generally large quantities of flat-fish were caught are hardly visited any more by these fish; and that, although there is a considerable increase in the number of fish brought into the market, this increase does not bear the due proportion to the increase of the fishing industries. There is, consequently, a tendency in England to limit the use of the trawl-net near the coast, and various experiments have been made to diminish the hurtfulness of this net. Among these attempts we must mention the one made by De Caux, and exhibited at Berlin in 1880, which consisted of replacing the trawl-heads by wheels, and stringing large wooden balls on the bottom rope so as to prevent it from cutting too deeply into the bottom, and to let it glide over places overgrown with plants without injuring the vegetation.

MESHES OF NETS.—It is a serious drawback that the meshes of the trawl-net, which, at the back part of the net, are generally 4 centimeters

[1½ inches] wide, are drawn out into a long and narrow shape when the net is in use, so that—especially if some sea-weeds or mud get into the net—they will not let even the smallest fish pass through. Mr. Schreiber, of Lowestoft, has atttempted to remedy this by sewing into the meshes of the net a number of large metal rings to form holes, which are constantly open, and through which the young fry may escape. Still better is an invention made by De Caux and Read, by which the meshes at the back part of the net are made wider, and in addition it is sometimes spread over hoops, so that all the meshes are kept open while the net is in use. Thus, the sand or mud which has entered the net is constantly washed out by the current, a way of escape is opened for the young fry, and the hauling of the net is greatly facilitated. Trawls of this kind are, therefore, urgently recommended, and it should be taken into serious consideration whether the same change could not be made in our "*kurren*," "*keitil*," and "*zeesen*."

THE SEINE FISHERIES.—These are nothing like so extensive in England as the trawl fisheries, but nevertheless they yield a considerable quantity of fish, especially herring and mackerel. In Scotland there were engaged in these fisheries, in 1880, 70,000 persons and 15,000 boats, and in 1881 the Scotch herring fisheries alone yielded 200,000 tons, valued at 44,000,000 marks [$10,472,000]. The seine fisheries have been considerably improved by the introduction of machine-made cotton nets, which are lighter, cheaper, and more durable than nets made of hemp or flax. A vessel which would formerly take out 950 meters [about 1,040 yards] of netting of a depth of 6 or 7 meters now takes 3,300 meters [about 3,609 yards] with a depth of 10 meters [about 32⅘ feet], which do not weigh any more than the 950 meters; and such a vessel has a total net area of 33,000, instead of 6,000 square meters, as formerly. In 1879 Germany imported from Scotland, Norway, and Holland in all 1,274,146 barrels of herring, valued at nearly 32,000,000 marks [$7,616,000]—herring which were caught in the North Sea, and which might just as well have been caught by German fishermen. Of the 745,000 barrels of herring exported from Scotland in 1881, Germany bought no less than 632,000 barrels.

SCOTCH FISHERIES.—It is true that the conditions are not so favorable for German high-sea fisheries as they are in Scotland, where, owing to the short distance between the fishing-grounds and the coast, small boats can be used in the fisheries; but then we are as favorably situated in this respect as the Netherlands, and German fishing-vessels could go to the places where herring are principally caught, just as well as English and Scotch trawlers can fish all the way from Texel to Heligoland and Harnsreef.

If the attempts at herring-fisheries, made from Emden again and again for nearly three centuries, have not led to any satisfactory results, in spite of considerable subsidies from the Government, the reason therefor must probably be found in the circumstance that these fisheries have

been conducted on too small a scale. If our sea-fisheries are to compete successfully with the enormous fisheries of other countries great capitalists should interest themselves in the matter. Considering the expensive material, favorable results will never be obtained with little capital. A herring-lugger of 100 tons costs 29,000 marks [$6,902], the outfit for trawling 7,000 marks [$1,666], and the two sets of nets which are required 10,000 marks [$2,380]. With a small capital, and the small number of ten or twelve vessels, the loss of a single lugger, or poor fisheries, which are more likely to occur with a small fleet of fishing-vessels than with a large one, which can go over a much larger area, may have the most serious consequences. English fishery associations and some private individuals therefore work with entirely different means. During my stay in London Mr. Burdett-Coutts equipped a fleet of from 60 to 70 large vessels, which were accompanied by 3 or 4 steamers to convey the fish quickly to the markets and supply the fishermen with food, ice, &c. According to the data contained in a very interesting treatise by His Royal Highness the Duke of Edinburgh, on the English sea-fisheries, one of the largest fish-dealers owns about 200 large vessels, of which from 140 to 150 are constantly employed, and are accompanied by 5 or 6 steamers, furnishing in 1881 for the London market 15,000 tons of fish, valued at 5,500,000 marks [$1,309,000]. Whenever great capitalists in Germany will invest their capital in the sea-fisheries, as they have done in the great steamship lines, we may hope to reap a rich harvest in the North Sea, to give good employment to thousands of persons, and educate a large number of experienced sailors, a circumstance the importance of which cannot be undervalued in view of the fact that sailing vessels are constantly being thrown more and more into the background by steamers.

For improving our sea-fisheries, however, it would not be sufficient to find the means for equipping a large fishing-fleet; we would also need ports accessible at all times, and as near as possible to the fishing-grounds. As the construction of harbors is very expensive, a project by Greenway Thomas, exhibited at the London Exhibition, for constructing cheap harbors in any place, even in the middle of the sea, deserves to be carefully examined.

A FLOATING WAVE-BREAKER.—In this project for fishing-ports, which are to serve merely as temporary places for anchoring and as places of refuge, Greenway Thomas starts from the well-known fact that the water of the sea is violently agitated only near the surface, while at a depth of 5 meters [16.4 feet] the water is comparatively calm. His floating wave-breakers, hollow triangular prisms, made of pieces of sheet iron soldered together firmly, therefore draw only from 3 to 5 meters of water; their breadth is 10 meters, and the two sides exposed to the waves are slightly concave. These wave-breakers are anchored at intervals of 10 meters. If the waves roll against a row of such apparatus, each one of them does not have to sustain the full pressure of the water like a firm mole,

but it splits the waves like the prow of a vessel, and the concave sides lead one portion of the waves to the right and another to the left. As the same takes place at every one of these apparatus the waters from the right side of the one and from the left side of the other are drawn toward each other, mutually break their force, and at the same time prevent from going any farther that part of the wave which rolls against the space between two prisms, thus producing calm water back of the apparatus. While in other harbors a mole costs £1,000,000 sterling per mile, Greenway Thomas calculates that a mile of his wave-breakers would only cost from £10,000 to £30,000 [$50,000 to $150,000]. It would not be difficult to construct of such apparatus places of refuge near small fishing-stations, where, owing to the great expense, other harbors could never be constructed. On coasts where at certain seasons there is a good deal of moving ice, Greenway Thomas's wave-breakers might be taken up and stowed away safely before winter sets in.

FLOATING HARBORS.—In a similar manner Leeds has projected floating harbors, which, located on the principal fishing-grounds, could receive a large number of vessels and could be furnished with tanks for live fish, store-houses for nets and other apparatus, ice houses, &c. Thereby many accidents would be avoided which, as the Duke of Edinburgh remarks, occur in transporting the fish-boxes from the fishing-vessels to the steamers; and the fishermen would not be obliged to be inactive for some time, till the fish which they have caught have been taken up by the steamers, of which there is frequently not a sufficient number on hand.

ICING.—For keeping fresh fish, cold is nowhere in Europe employed in such a rational manner as in America, where fish are kept fresh for weeks and months in large storehouses which are constantly kept cool by ice-machines, thereby preventing any loss if the number of fish caught has been larger than the immediate demand, and enabling dealers to supply the markets regularly, even if at times the fisheries have not been very successful. In America common fish are frozen hard, just as in Russia, while the finer kind of fish, in order not to lose any of their delicate flavor, are only cooled off a little above the freezing point.

FREIGHT RATES.—For the transportation of fish we use cold only in a very primitive manner, by packing the fish in baskets between layers of ice. Thereby the weight is considerably increased, the freight becomes more expensive, and by the melting of the ice the fish become watery and lose their flavor. The general introduction of ice-cars, such as we have on some European railroads, would make it unnecessary to pack the fish in ice; they would keep better and the cost of freight would be diminished. The wholesale transportation of cheap salt-water fish to the interior of Germany has thus far been made almost impossible by the high rates of freight on the railroads. That it is possible to transport fish at much cheaper rates, we see in America,

where ordinary and express trains carry enormous quantities of fish and other products of the sea in suitable ice-cars for enormous distances, and bring these wholesome and cheap articles of food within the reach of the masses in the interior of the country. It is not to be supposed that the American railroad companies transport fish at a loss to themselves merely to please the great public; and if such a thing is possible in America, it can certainly be also done in Europe. Complaint is also made in England, where thousands of tons of fish are regularly shipped by railroad, that the freight rates are exorbitant, the Great Western Railroad, for instance, charging eight times as much freight for fish as for coal, while other English railroads charge at least three times as much for sprats and herring as for coal. Fine fish, such as salmon, sole, &c., which are eaten only by the wealthier classes, can stand a high freight-rate, which is not the case with the more common fish which are to serve as food for the masses. If, as is frequently the case, the freight charges exceed the value of the fish, the inland towns will have to do without fish, while on the coast, after the local demand has been satisfied, enormous masses of fish are either not caught at all, or, if caught, are used only as manure.

PRESERVED FISH.—The manufacture in Germany of preserved fish, by which its original cost is greatly increased, leaves much to be desired. There was in London a very full exhibit of fish preserved in various ways. The progress in this direction made in some coast-towns of Schleswig-Holstein and Pomerania, especially in the matter of smoking and pickling fish, should be an encouragement to our entire coast population; and we would urge our manufacturers to make a careful study of the many different articles in this line prepared in foreign countries, so as enable them to offer a greater variety to our German public. In all these factories special attention should be given to a rational use of all the refuse for oil, glue, and guano, whereby not only the running expenses are covered, but which also frequently yields a considerable surplus.

DANGERS TO FISHERMEN.—Mechanicians emulate each other in the most commendable manner in protecting fishermen against the many dangers which threaten them in their difficult calling. Thus, a large number of machines for hauling in nets was exhibited, which, worked by hand or by steam, easily and rapidly do a work which was otherwise both laborious and dangerous. These machines are in general use in England, and will undoubtedly meet with universal approval among those of our fishermen who have to handle large nets.

Regard for the easy handling of the nets requires that the fishing vessels should have as low a railing as possible, which cannot afford shelter to the men who are employed on the deck, so that in a rough sea they often have to move on their knees and elbows, in spite of which men are frequently washed overboard. Even in calm weather, if the deck should be covered with ice, the mere slipping of a foot may cause

the loss of a man, and but too often one such loss brings about the loss of the whole vessel, which in stormy weather can no longer be managed by the diminished crew. To prevent such accidents, Mr. Gunn, of Galspie, has invented an apparatus which, in spite of the proverbial carelessness of fishermen, has been favorably received by them and has met with the approval of competent judges. It consists of a movable railing, made of strong iron bars, which can be put up or taken down with one move, and which forms an excellent protection for the crew. This apparatus, which can easily be put up on any open or covered vessel and is not at all in the way, costs for a large fishing cutter measuring 50 feet in length and costing 30,000 marks [$7,140] only 200 marks [$47.60], and cannot be too strongly recommended to fishermen.

CORK-COAL.—Of special importance to fishermen I consider a preparation exhibited by De la Sala, of Seville, in the Spanish department of the exhibition, viz., cork-coal. The specific weight of this mass is much less than that of cork. This material, which is particularly recommended for safety-belts, is especially suited to take the place of the inconvenient and expensive cork-jackets, which are very much disliked by the fishermen, and to furnish them with convenient and warm clothes which do not hinder them in their work, which can therefore be worn at all times, and will prevent a person from sinking. For preparing cork-coal any cheap refuse of corks can be used, which after having been turned to coal can easily be pulverized and put in the lining of clothes. Some experiments which I made show that cork-coal in water can bear 10 to 12 times its weight, almost three times as much as the same weight of cork, and does not absorb near so much water. As a stout man with thick clothing when in the water weighs only 6 or 7 pounds, from 300 to 400 grams [about 13 oz.] of cork-coal inserted in the lining of his jacket or vest are sufficient to keep him afloat. I have had a number of such clothes made and distributed them among fishermen for the purpose of having them tried.

LOOSENING FROM THE DAVITS.—In stormy weather great difficulty is frequently experienced in getting the boats loosened from the davits in time, and especially in getting them off both hooks at the same instant. If this is not done quickly, the waves may throw the boat against the side of the vessel and dash it to pieces, and if a hook is loosened prematurely, the boat hanging to the other hook may in a stormy sea easily assume a vertical position and throw the men out. Among the many contrivances aiming at an easy and simultaneous loosening of the connections, that exhibited by Sample & Ward seems the most suitable, because based simply on the principles of gravity and of the lever. This simple apparatus can be attached to any boat at a very trifling expense, and can be covered so completly, that there is no chance of its being damaged.

In case a vessel which can no longer be managed properly is to be turned head against the waves, and is in this way to be placed in the

most favorable position, and if the common anchor cannot be cast either because the water is too deep or for some other reason, so-called floating anchors are frequently employed, which, quickly put together from pieces of wood-work and sail-cloth and attached to a rope, and being thrown overboard, drift more slowly than the vessel, and therefore bring it into the desired position. A simple and cheap anchor of this kind, which when folded together takes up but very little room and is therefore well adapted to fishing-boats, and is always ready for use, was exhibited by Bullivant.

OILING THE WAVES.—Even ancient writers speak of the use of oil for calming the waves of the sea; it is well known that whalers and, on a small scale some of our fishing vessels, calm the water within a wide circumference by the oil dripping from them; but not until recently has a beginning been made of putting this knowledge to more general use. The construction of pipe-lines for oil at the bottom of the Peterhead harbor, through which oil is pumped in order to make it easier for ships to enter the harbor in stormy weather, has proved very successful. Small oil apparatus carried on board vessels and boats, which, especially when the boats are to be let down, calm the waters around the vessel and which are said to protect the boats against strong waves, were exhibited by Bowman of Huntly, and the reports concerning them were exceedingly favorable. I have had some of these apparatus made and given them to some fishermen on our coast for a trial.

INSURANCE.—In England special attention is justly paid to the improvement of the social condition of the fishermen, and it was pointed out repeatedly, especially by His Royal Highness the Duke of Edinburgh, how necessary it is to urge the fishermen to insure their lives, and mutually to insure their boats and nets; which precaution unfortunately meets with but little favor among those whose sole property consists in boats and nets. In England private aid is extended on the most liberal scale in every calamity; and, as regards popularizing the insurance referred to above, some clergymen in the fishing villages have been untiring in their efforts. A work by De Caux on the insurance of fishermen was awarded a prize by the jury, and will soon appear in print. Years ago an attempt was made to start an insurance association among our Baltic fishermen, who often suffer severely from the loss of their lines and nets, but unfortunately the project was abandoned owing to the circumstance that it was very difficult to estimate the damage.

SALMON.—Of the English fresh-water fish, the salmon alone is of any economical importance. In consequence of the planting of young salmon, the construction of numerous salmon-ways, and the time when it is prohibited to catch salmon—one hundred and fifty days per annum, besides forty-eight hours every week—the salmon fisheries have everywhere increased very considerably. Thus, in a small Irish river, the Moy, which had been rendered accessible to the salmon only by the con-

struction of a pass, and which had been stocked with several hundreds of thousands of artificially hatched fish, the rent of the fisheries after a few years yielded the large sum of £27,000 sterling [about $135,000]. On a still larger scale are the results which have been reached by the artificial hatching of salmon in America, as in the Sacramento River, where, according to Prof. Spencer F. Baird, the yield was annually increased by 5,000,000 pounds, and where more salmon are caught than can be used by the numerous factories for preparing fish. In Germany, likewise, the young salmon which have been planted here and there, though on a very modest scale, have proved a decided success, making it exceedingly desirable to pursue energetically this path, which has been recognized as the right one for increasing the number of these fish.

Summer spawners.—For feeding the masses, however, the fish which spawn in summer, and which are found in our numerous rivers and lakes, are, for Germany, of far greater importance than the salmonoids. Their propagation is easier, can be accomplished without any special apparatus, and is even now very successfully carried on in many places in Germany. I was much interested, when in London, to learn from reports from distant countries that, contrary to the opinions that the increase of fish which spawn in summer is a mere useless play, the fishermen are not in the least to blame as regards the decrease of fish in our inland waters, but that this is caused simply by river improvements and the pollution of the water; yet in localities where river improvements and the pollution of the water are unknown the number of fish has been noticeably decreased simply by too exhaustive fishing. In Canada, for example, lakes 400 to 500 miles long have been depleted of fish from this cause, and in the Volga the size of the various kinds of sturgeon has decreased for the same reason; so that the weight of the roe, which, comparatively speaking, is much greater in large than in small fish, and which twenty years ago was one nineteenth of the total weight of the body, has decreased steadily, until it is now only one forty-fourth. Facts like these ought to cause serious thoughts, even with those people from whom we are accustomed to hear again and again that, compared to the destruction of fry and fish by natural enemies, the violence of man is without any noticeable influence as regards the number of fish; the same people, strange to say, complain in one and the same breath, that if the fisheries are limited the number of fish will become too great, and that consequently the individual fish can no longer reach their proper size. In making such assertions people have hardly thought of the last conclusions to be drawn therefrom, viz., that in the inclosed waters of thinly populated districts all fish must become dwarfed.

Pollutions.—The hurtful influence of river improvements and the pollution of water by factories, &c., can, of course, not be denied, and everywhere efforts are made to keep the waters pure without interfering with the manufacturing interests. At the London Exhibition the Na-

tive Guano Company exhibited a working model of their so-called A B C process for cleaning filthy water, by which astonishing results are obtained, and which deserves the fullest examination.

DEEP-SEA RESEARCH.—In all the speeches and treatises called forth by the exhibition, constant stress is laid on the circumstance that for promoting the fisheries, and especially as a basis for legislation, there is needed an intimate knowledge of the waters, the nature of the bottom, depth, vegetation, and fauna, and on the other hand an exhaustive study of the biological conditions of fish, their distribution, places of sojourn, migrations, food, and propagation. My deceased teacher and friend, Prof. August Müller, deserves special credit for having, as early as 1858, in a paper read at a meeting of the Berlin Acclimatization Society, pointed out the absolute necessity for such investigations, and urged their vigorous prosecution by the Government, through the appointment of special officers, and the establishment of experimental stations. The correctness of his views has since been generally recognized. In Prussia the Scientific Commission for investigating the German Seas has produced some excellent works; private individuals and fishery associations have devoted all their efforts to the solution of similar problems; and in many other countries naturalists and practical fishermen emulate with each other in their endeavors to solve many problems of the highest importance to the fisheries. Even at the Berlin Exposition we had occasion to admire the excellent Norwegian maps showing the varying temperature and depth of the Polar Sea; and in London numerous similar works had been placed on exhibition by different countries, among them one of special interest to us in Germany, the magnificent atlas of the North Sea, by Captain Olsen, which, in about fifty sheets, shows the varying depths, character of the bottom, direction and velocity of the tides, fishing-grounds, and, in a particularly clear and instructive manner, the distribution of some forty of the more important species of fish.

GERMANY SHOULD IMITATE THE UNITED STATES.—If such investigations, as to the necessity of which there is at the present time not the slightest doubt, are to be carried on successfully and rapidly, they must not be left to the occasional liberality of private individals or associations, or be given as a mere side occupation to men whose time is otherwise employed, and who can devote thereto only a few leisure hours; but such investigations require the full and undivided labor of persons specially appointed for this purpose. If it has once been recognized that the sea and inland fisheries are of vast economical importance to Germany, and if, by careful experiments on a small scale carried on for a number of years, people have became convinced of the successful results which accompany the rational cultivation of our water area, the time has arrived to pursue the same object on a large scale. In this respect the United States Commission of Fish and Fisheries may well serve as a model. Already at the Berlin Exposition this Commission

showed that it had far outstripped all similar efforts made by other countries, and obtained the prize of honor given by His Majesty the Emperor, and in London the prize was unanimously accorded to it as being the model institution of this kind. From America we may learn that liberal appropriations for promoting the fisheries bear a rich interest.

Allow me, therefore, to conclude by expressing the hope, that as during the last decades agriculture and industry have been powerfully promoted by the wise measures of the Government, the German sea and inland fisheries may likewise flourish and reach a high degree of development, thus contributing their share towards increasing the welfare and honor of our country.

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